CROPCAST
JULY 31, 1990
1990 BASE YIELD CALCULATION

| PROVINCE | NATIONAL BASE YIELD (KG/HA) | PROVINCE COEFFICIENT | PROVINCE BASE YIELD (KG/HA) | IRRIGATED BASE YIELD (KG/HA) | RAINFED BASE YIELD (KG/HA) |
|---|---|---|---|---|---|
| WEST REGION - 1 | | | | | |
| Herat | 1250 | 1.30 | 1625 | 1670 | 835 |
| NORTHWEST REGION - 2 | | | | | |
| Badghis | 1250 | 0.75 | 940 | 1720 | 860 |
| Farayab | 1250 | 0.70 | 875 | 1620 | 810 |
| Jowzjan | 1250 | 0.70 | 875 | 1460 | 730 |
| Balkh | 1250 | 0.90 | 1125 | 1740 | 870 |
| Samangan | 1250 | 1.05 | 1310 | 1570 | 785 |
| NORTH REGION - 3 | | | | | |
| Baghlan | 1250 | 1.15 | 1440 | 1560 | 780 |
| Kunduz | 1250 | 1.15 | 1440 | 1620 | 810 |
| Takhar | 1250 | 1.00 | 1250 | 1630 | 815 |
| NORTHEAST - 4 | | | | | |
| Badakhshan | 1250 | 0.75 | 940 | 1330 | 665 |
| CENTRAL - 5 | | | | | |
| Bamyan | 1250 | 0.90 | 1125 | 1240 | 620 |
| Ghor | 1250 | 0.85 | 1060 | 1280 | 640 |
| EAST CENTRAL - 6 | | | | | |
| Parwan | 1250 | 1.25 | 1560 | 1610 | 805 |
| Kapisa | 1250 | 0.95 | 1310 | 1310 | 655 |
| Laghman | 1250 | 0.95 | 1310 | 1340 | 670 |
| Kabul | 1250 | 0.95 | 1310 | 1350 | 675 |
| Wardak | 1250 | 0.95 | 1310 | 1310 | 655 |
| Lowgar | 1250 | 1.10 | 1375 | 1430 | 715 |
| SOUTH CENTRAL - 7 | | | | | |
| Uruzghan | 1250 | 0.90 | 1125 | 1210 | 605 |
| Ghazni | 1250 | 1.15 | 1440 | 1480 | 740 |
| Zabul | 1250 | 1.20 | 1500 | 1580 | 790 |
| EAST - 8 | | | | | |
| Ninghrehar | 1250 | 1.00 | 1250 | 1340 | 670 |
| Kunar | 1250 | 1.10 | 1375 | 1500 | 750 |
| Paktia/Paktika | 1250 | 1.10 | 1375 | 1440 | 720 |
| SOUTHWEST - 9 | | | | | |
| Kandahar | 1250 | 1.30 | 1625 | 1650 | 825 |
| Helmand | 1250 | 1.25 | 1563 | 1710 | 855 |
| Farah | 1250 | 1.00 | 1250 | 1250 | 625 |
| Nimruz | 1250 | 1.00 | 1250 | 1250 | 625 |

CROPCAST
JULY 31, 1990
1990 ACTUAL YIELD CALCULATION

| PROVINCE | IRRIGATED BASE YIELD (KG/HA) | RAINFED BASE YIELD (KG/HA) | 1990 IRRIGATED ADJUSTMENT FACTOR | 1990 RAINFED ADJUSTMENT FACTOR | FORECAST IRRIGATED YIELD (KG/HA) | FORECAST RAINFED YIELD (KG/HA) |
|---|---|---|---|---|---|---|
| WEST REGION | | | | | | |
| Herat | 1670 | 835 | 0.95 | 0.80 | 1587 | 668 |
| NORTHWEST REGION | | | | | | |
| Badghis | 1720 | 860 | 0.85 | 0.60 | 1462 | 516 |
| Farayab | 1620 | 810 | 0.80 | 0.50 | 1296 | 405 |
| Jowzjan | 1460 | 730 | 0.85 | 0.60 | 1241 | 438 |
| Balkh | 1740 | 870 | 0.95 | 0.90 | 1653 | 783 |
| Samangan | 1570 | 785 | 1.00 | 1.00 | 1570 | 785 |
| NORTH REGION | | | | | | |
| Baghlan | 1560 | 780 | 1.00 | 1.00 | 1560 | 780 |
| Kunduz | 1620 | 810 | 1.00 | 1.00 | 1620 | 810 |
| Takhar | 1630 | 815 | 1.05 | 1.05 | 1712 | 856 |
| NORTHEAST | | | | | | |
| Badakhshan | 1330 | 665 | 1.15 | 1.20 | 1529 | 798 |
| CENTRAL | | | | | | |
| Bamyan | 1240 | 620 | 1.10 | 1.20 | 1364 | 744 |
| Ghor | 1280 | 640 | 1.05 | 1.10 | 1344 | 704 |
| EAST CENTRAL | | | | | | |
| Parwan | 1610 | 805 | 1.00 | 0.95 | 1610 | 765 |
| Kapisa | 1310 | 655 | 0.95 | 0.85 | 1245 | 557 |
| Laghman | 1340 | 670 | 1.05 | 1.10 | 1407 | 737 |
| Kabul | 1350 | 675 | 1.00 | 1.00 | 1350 | 675 |
| Wardak | 1310 | 655 | 1.00 | 1.00 | 1310 | 655 |
| Lowgar | 1430 | 715 | 1.00 | 1.00 | 1430 | 715 |
| SOUTH CENTRAL | | | | | | |
| Uruzghan | 1210 | 605 | 1.00 | 1.00 | 1210 | 605 |
| Ghazni | 1480 | 740 | 1.05 | 1.10 | 1554 | 814 |
| Zabul | 1580 | 790 | 1.05 | 1.10 | 1659 | 869 |
| EAST | | | | | | |
| Ninghrehar | 1340 | 670 | 1.05 | 1.10 | 1407 | 737 |
| Kunar | 1500 | 750 | 1.10 | 1.20 | 1650 | 900 |
| Paktia/Paktika | 1440 | 720 | 1.05 | 1.10 | 1512 | 792 |
| SOUTHWEST | | | | | | |
| Kandahar | 1650 | 825 | 1.10 | 1.20 | 1815 | 990 |
| Helmand | 1710 | 855 | 1.05 | 1.10 | 1796 | 941 |
| Farah | 1250 | 625 | 1.00 | 1.00 | 1250 | 625 |
| Nimruz | 1250 | 625 | 1.05 | 1.10 | 1313 | 688 |

CROPCAST
JULY 31, 1990
COMPONENT PRODUCTION

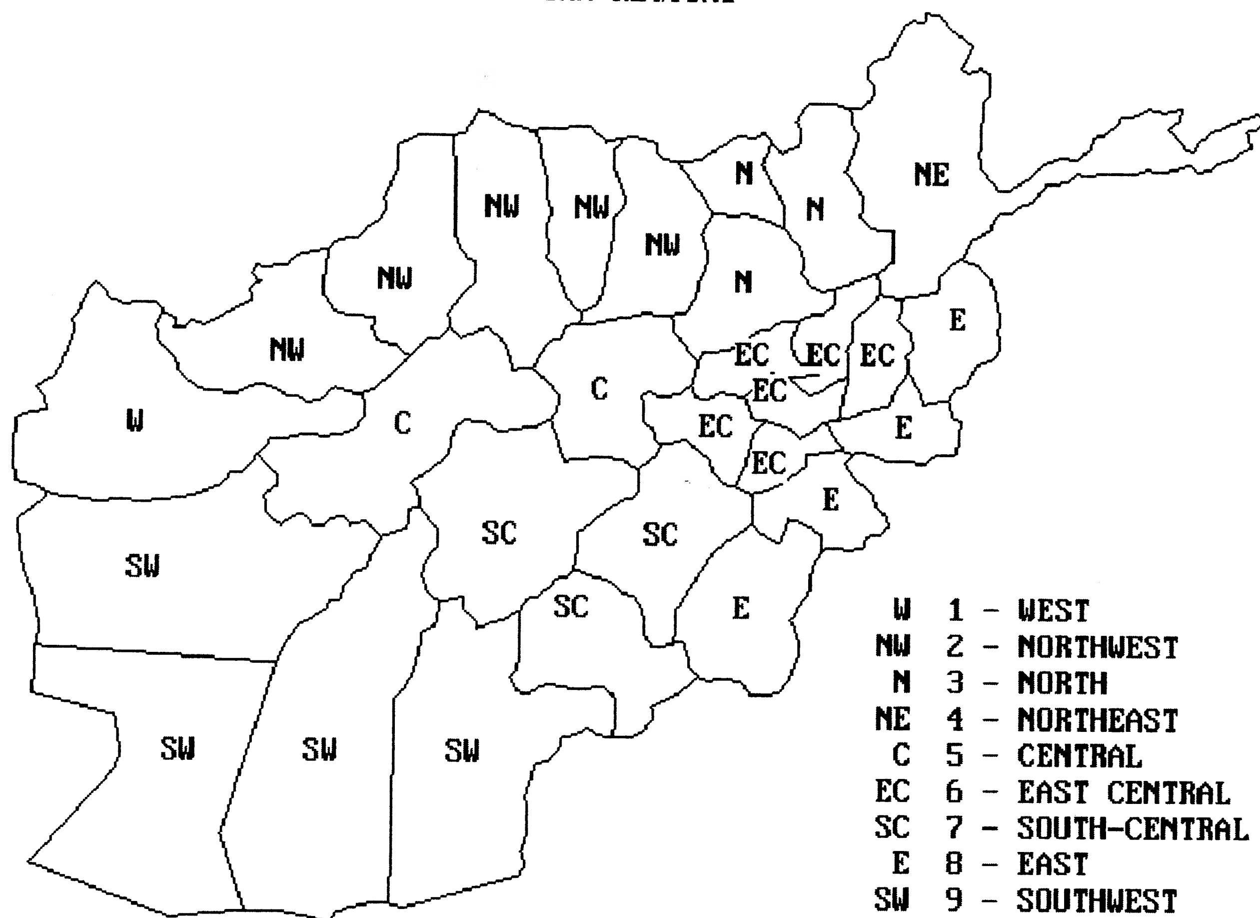
| PROVINCE | FORECAST IRRIGATED AREA (HECTARE) | FORECAST IRRIGATED YIELD (KG/HA) | FORECAST IRRIGATED PRODUCTION (1000 MT) | FORECAST RAINFED AREA (HECTARE) | FORECAST RAINFED YIELD (KG/HA) | FORECAST RAINFED PRODUCTION (1000 MT) |
|---|---|---|---|---|---|---|
| WEST REGION | | | | | | |
| Herat | 242,850 | 1587 | 385,282 | 11,900 | 668 | 7,949 |
| NORTHWEST REGION | | | | | | |
| Badghis | 6,580 | 1462 | 9,620 | 62,170 | 516 | 32,080 |
| Farayab | 12,830 | 1296 | 16,628 | 144,940 | 405 | 58,701 |
| Jowzjan | 25,790 | 1241 | 32,005 | 108,590 | 438 | 47,562 |
| Balkh | 51,200 | 1653 | 84,634 | 129,350 | 783 | 101,281 |
| Samangan | 72,320 | 1570 | 113,542 | 36,980 | 785 | 29,029 |
| NORTH REGION | | | | | | |
| Baghlan | 74,030 | 1560 | 115,487 | 13,160 | 780 | 10,265 |
| Kunduz | 102,000 | 1620 | 165,240 | 24,980 | 810 | 20,234 |
| Takhar | 124,450 | 1712 | 212,996 | 112,350 | 856 | 96,144 |
| NORTHEAST | | | | | | |
| Badakhshan | 37,160 | 1529 | 56,821 | 54,240 | 798 | 43,272 |
| CENTRAL | | | | | | |
| Bamyan | 17,220 | 1364 | 23,488 | 4,020 | 744 | 2,991 |
| Ghor | 70,810 | 1344 | 95,169 | 37,270 | 704 | 26,238 |
| EAST CENTRAL | | | | | | |
| Parwan | 10,810 | 1610 | 17,404 | 640 | 765 | 489 |
| Kapisa | 15,650 | 1245 | 19,476 | 0 | 557 | 0 |
| Laghman | 14,490 | 1407 | 20,387 | 570 | 737 | 420 |
| Kabul | 28,780 | 1350 | 38,853 | 1,570 | 675 | 1,060 |
| Wardak | 13,340 | 1310 | 17,475 | 0 | 655 | 0 |
| Lowgar | 5,210 | 1430 | 7,450 | 410 | 715 | 293 |
| SOUTH CENTRAL | | | | | | |
| Uruzghan | 58,770 | 1210 | 71,112 | 9,000 | 605 | 5,445 |
| Ghazni | 95,510 | 1554 | 148,423 | 5,570 | 814 | 4,534 |
| Zabul | 42,230 | 1659 | 70,060 | 4,200 | 869 | 3,650 |
| EAST | | | | | | |
| Ninghrehar | 26,370 | 1407 | 37,103 | 4,080 | 737 | 3,007 |
| Kunar | 6,550 | 1650 | 10,808 | 1,310 | 900 | 1,179 |
| Paktia/Paktika | 47,860 | 1512 | 72,364 | 4,520 | 792 | 3,580 |
| SOUTHWEST | | | | | | |
| Kandahar | 29,200 | 1815 | 52,998 | 700 | 990 | 693 |
| Helmand | 24,040 | 1796 | 43,164 | 4,620 | 941 | 4,345 |
| Farah | 71,030 | 1250 | 88,788 | 0 | 625 | 0 |
| Nimruz | 123,400 | 1313 | 161,963 | 0 | 688 | 0 |
| TOTAL | 1,450,480 | 1509 | 2,188,738 | 777,140 | 649 | 504,441 |

Note: Production estimates based on initial, uncalibrated procedures. Errors in estimations of +/- 20% possible.

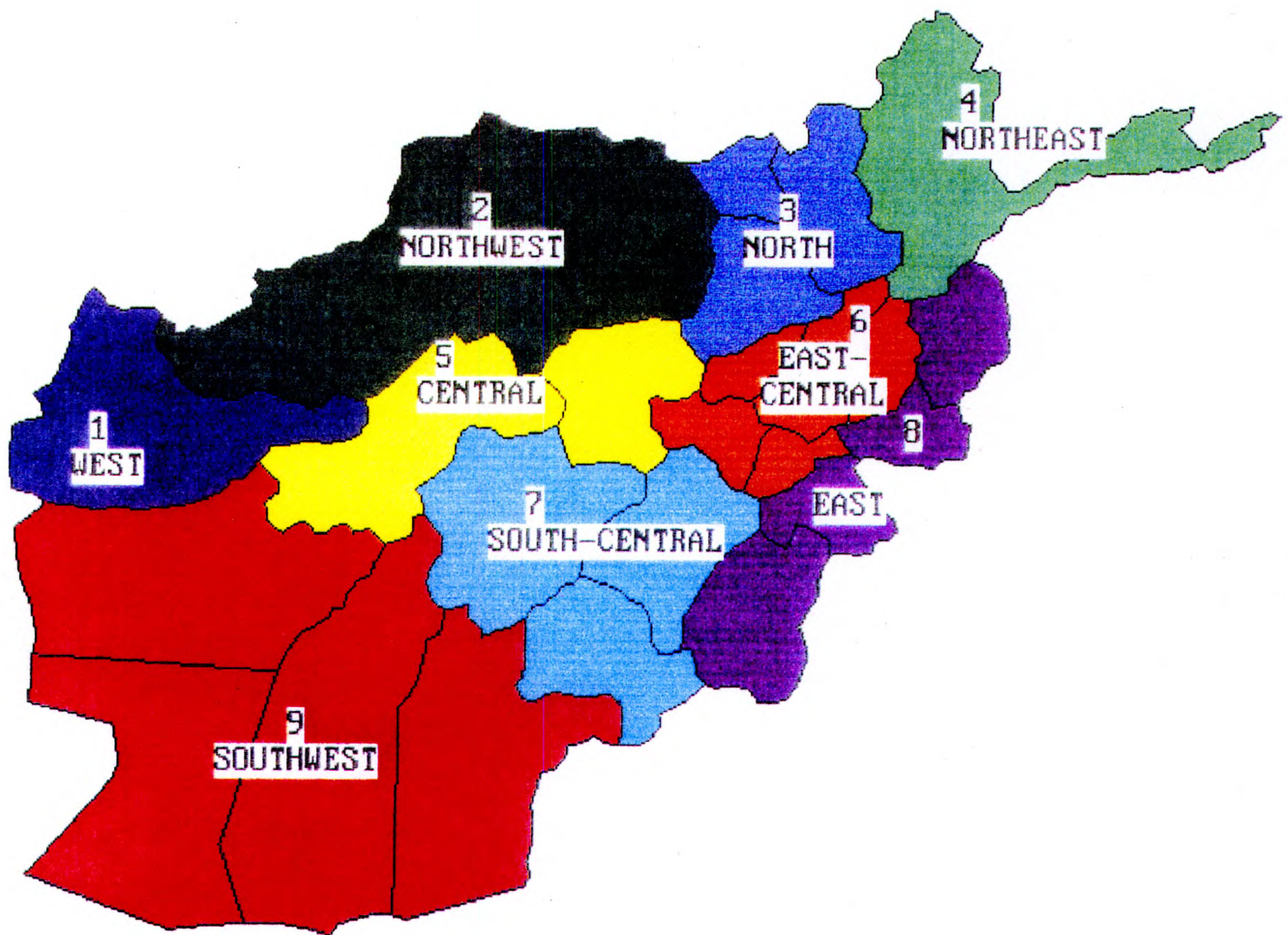
CROPCAST
JULY 31, 1990
1990 AFHGAN WHEAT ESTIMATE

| PROVINCE | TOTAL AREA (HECTARE) | YIELD (KG/HA) | TOTAL PRODUCTION (METRIC TONS) |
|---|---|---|---|
| WEST REGION - 1 | | | |
| Herat | 254,750 | 1544 | 393,231 |
| NORTHWEST REGION - 2 | | | |
| Badghis | 68,750 | 607 | 41,700 |
| Farayab | 157,770 | 477 | 75,328 |
| Jowzjan | 134,380 | 592 | 79,568 |
| Balkh | 180,550 | 1030 | 185,915 |
| Samangan | 109,300 | 1304 | 142,572 |
| NORTH REGION - 3 | | | |
| Baghlan | 87,190 | 1442 | 125,752 |
| Kunduz | 126,980 | 1461 | 185,474 |
| Takhar | 236,800 | 1305 | 309,140 |
| NORTHEAST - 4 | | | |
| Badakhshan | 91,400 | 1095 | 100,094 |
| CENTRAL - 5 | | | |
| Bamyan | 21,240 | 1247 | 26,479 |
| Ghor | 108,080 | 1123 | 121,407 |
| EAST CENTRAL - 6 | | | |
| Parwan | 11,450 | 1563 | 17,894 |
| Kapisa | 15,650 | 1245 | 19,476 |
| Laghman | 15,060 | 1382 | 20,808 |
| Kabul | 30,350 | 1315 | 39,913 |
| Wardak | 13,340 | 1310 | 17,475 |
| Lowgar | 5,620 | 1378 | 7,743 |
| SOUTH CENTRAL - 7 | | | |
| Uruzghan | 67,770 | 1130 | 76,557 |
| Ghazni | 101,080 | 1513 | 152,957 |
| Zabul | 46,430 | 1588 | 73,709 |
| EAST - 8 | | | |
| Ninghrehar | 30,450 | 1317 | 40,110 |
| Kunar | 7,860 | 1525 | 11,987 |
| Paktia/Paktika | 52,380 | 1450 | 75,944 |
| SOUTHWEST - 9 | | | |
| Kandahar | 29,900 | 1796 | 53,691 |
| Helmand | 28,660 | 1658 | 47,509 |
| Farah | 71,030 | 1250 | 88,788 |
| Nimruz | 123,400 | 1313 | 161,963 |
| TOTAL | 2,227,620 | 1209 | 2,693,179 |

Note: Production estimates based on initial, uncalibrated procedures. Errors in estimations of +/- 20% possible.

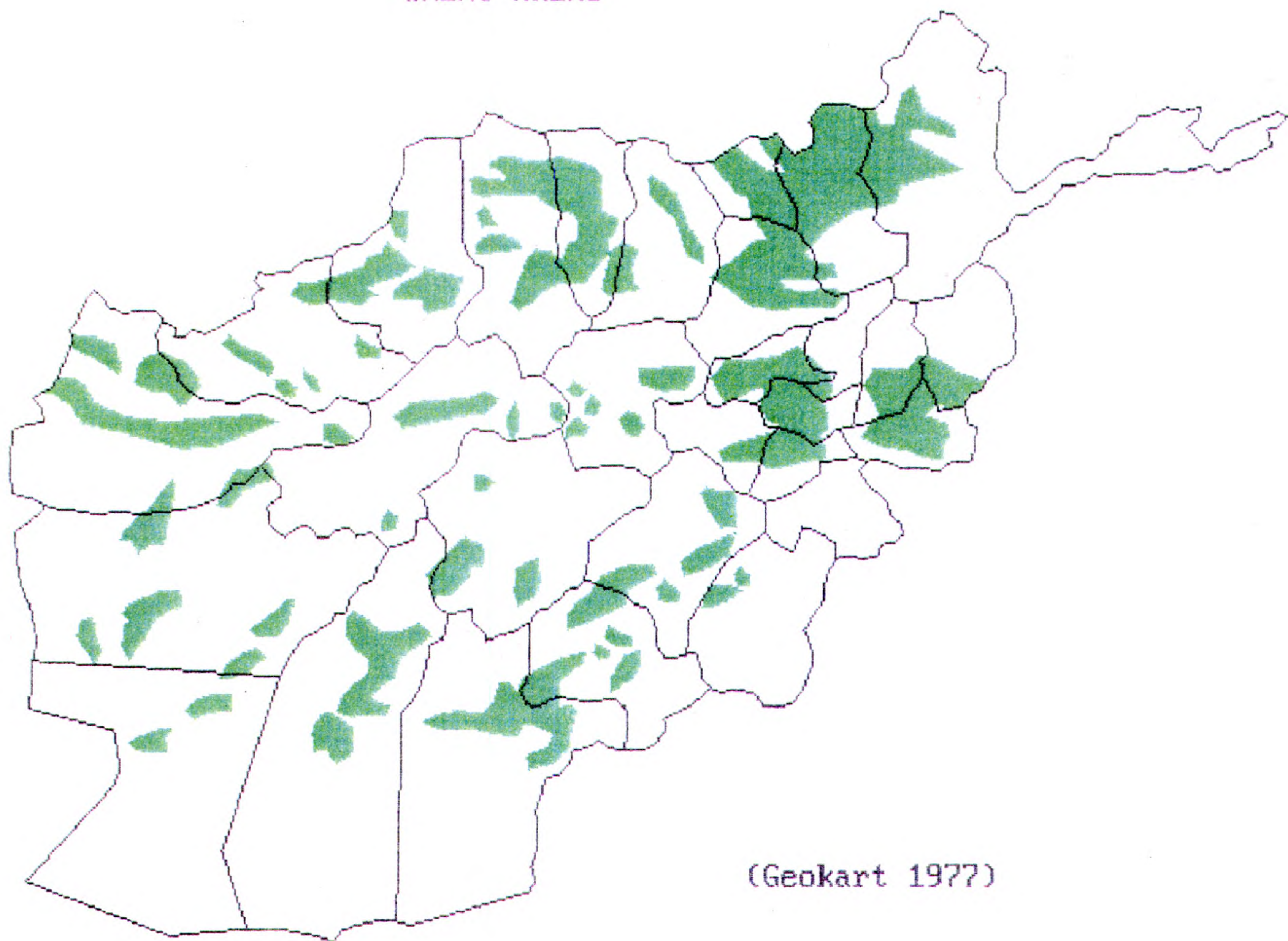



CROPCAST Regional Delineations

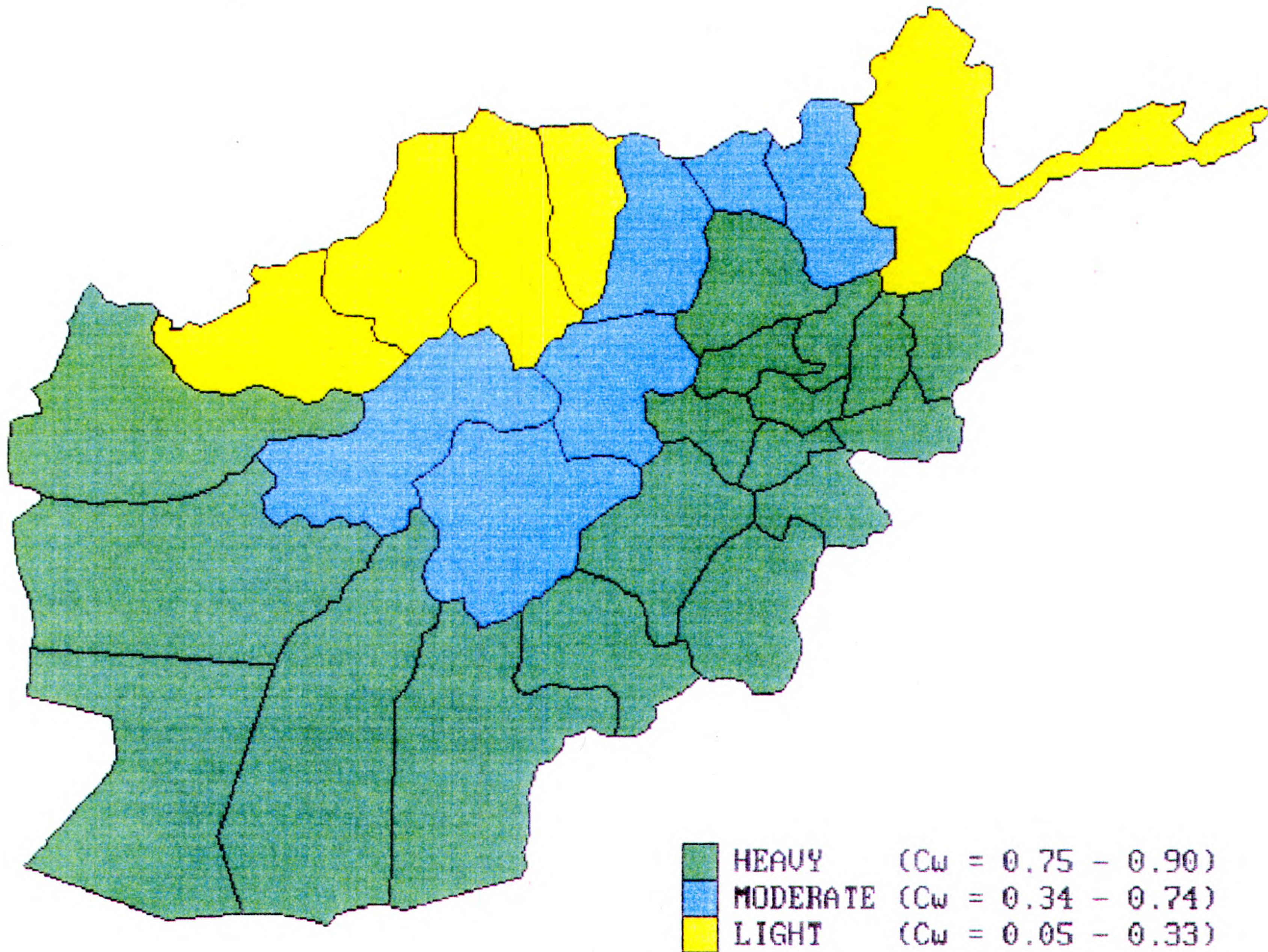



CROPCAST Regional Delineations

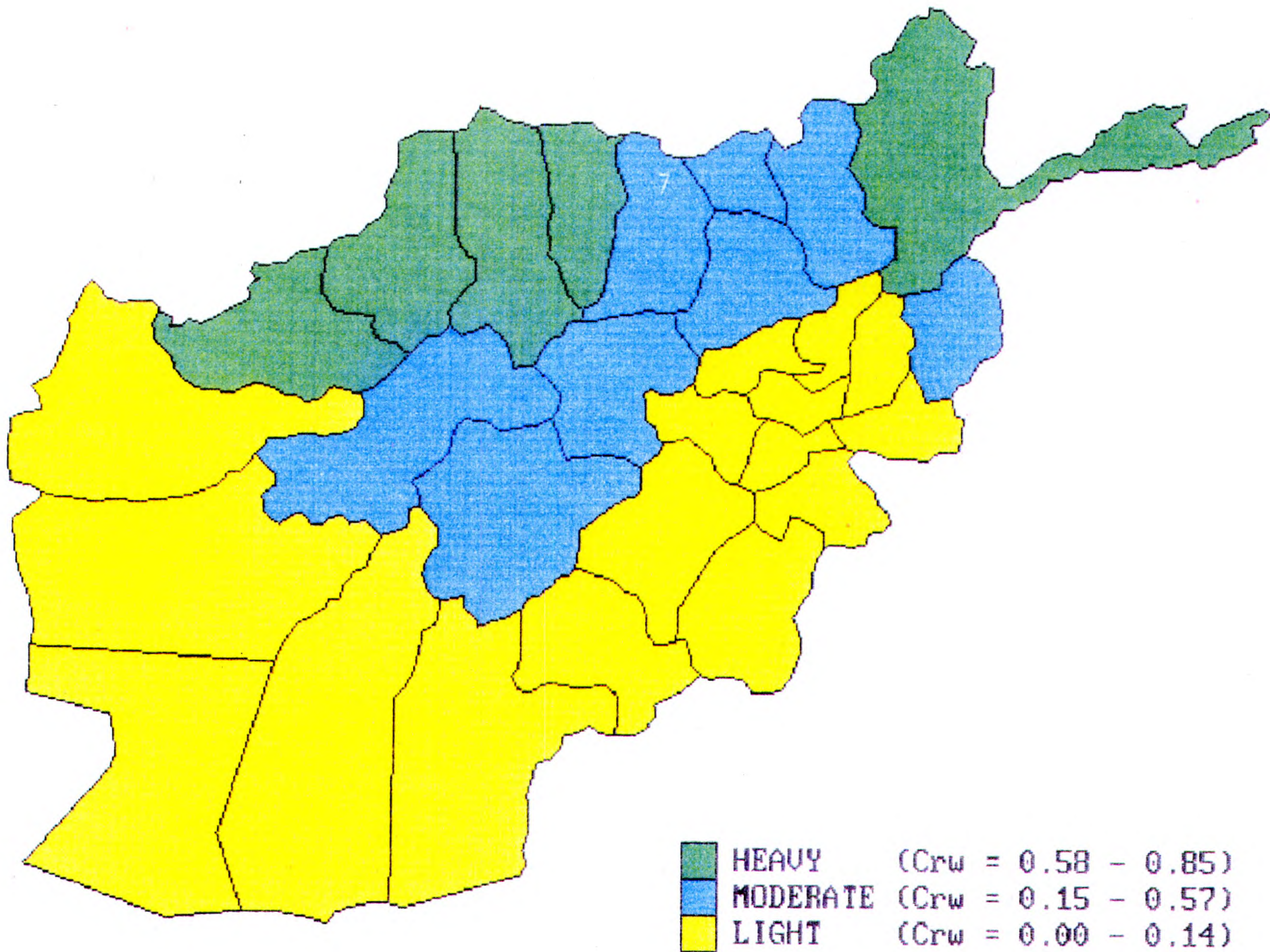
WHEAT AREAS



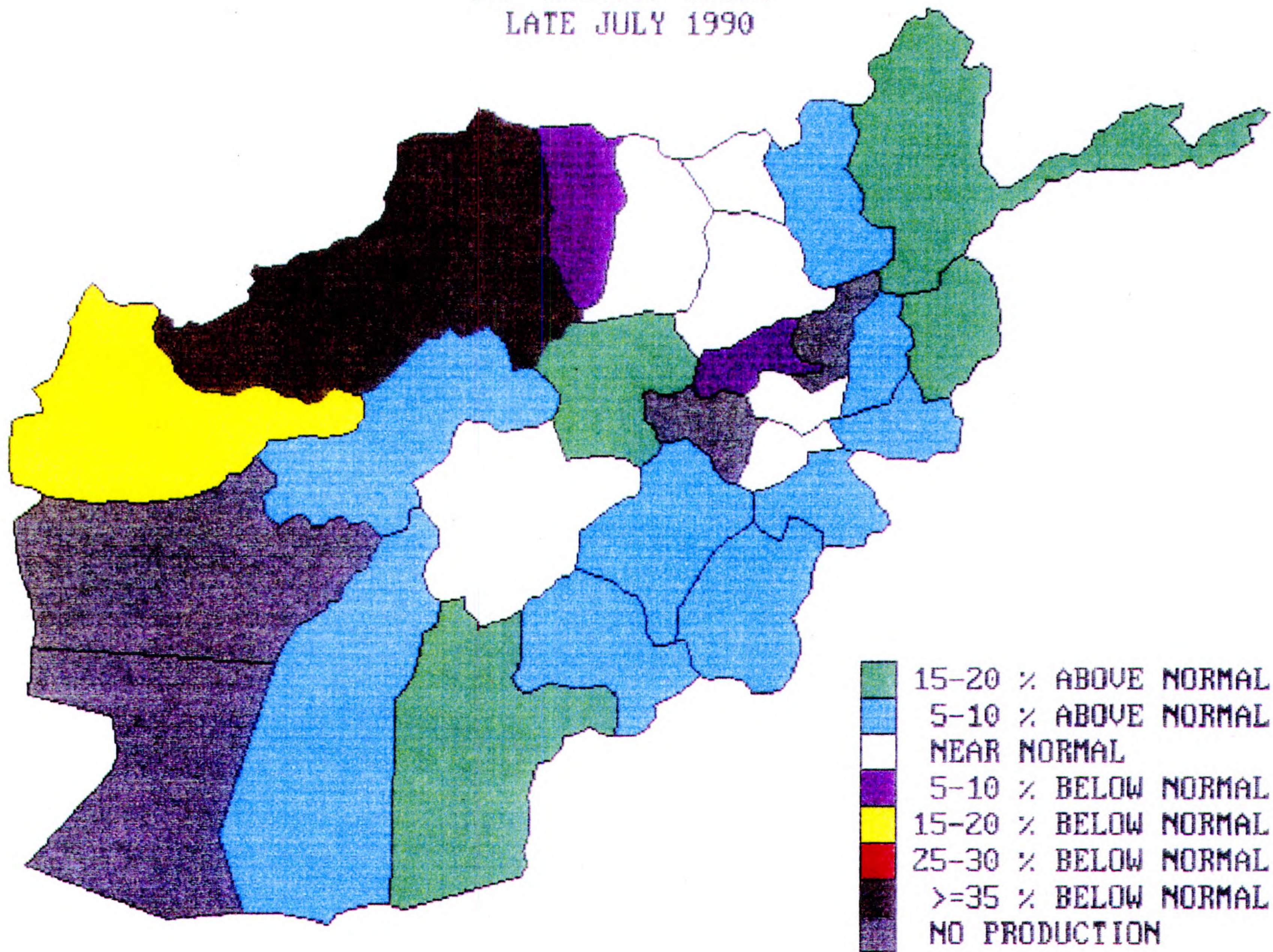
IRRIGATED WHEAT DOMINANCE




Based on several sources of historical Afghanistan agricultural data and expert opinion.




Based on several sources of historical Afghanistan agricultural data and expert opinion.




Based on initial CROPCAST modeling estimations. Errors in estimations of +/- 20% possible.

# CROPCAST™ INITIAL ESTIMATION PROCEDURES

## 1.0 CALCULATIONS OF PROVINCIAL BASE YIELDS

### 1.1 Assumptions for Base Yield Calculations

Four assumptions were made in the calculation of base yields for irrigated and non-irrigated wheat at the provincial level for Afghanistan. These four assumptions were:

1) There has been no technological trend in yields since the mid 1970's.

2) The normal national base yield is 1250 kilograms per hectare.

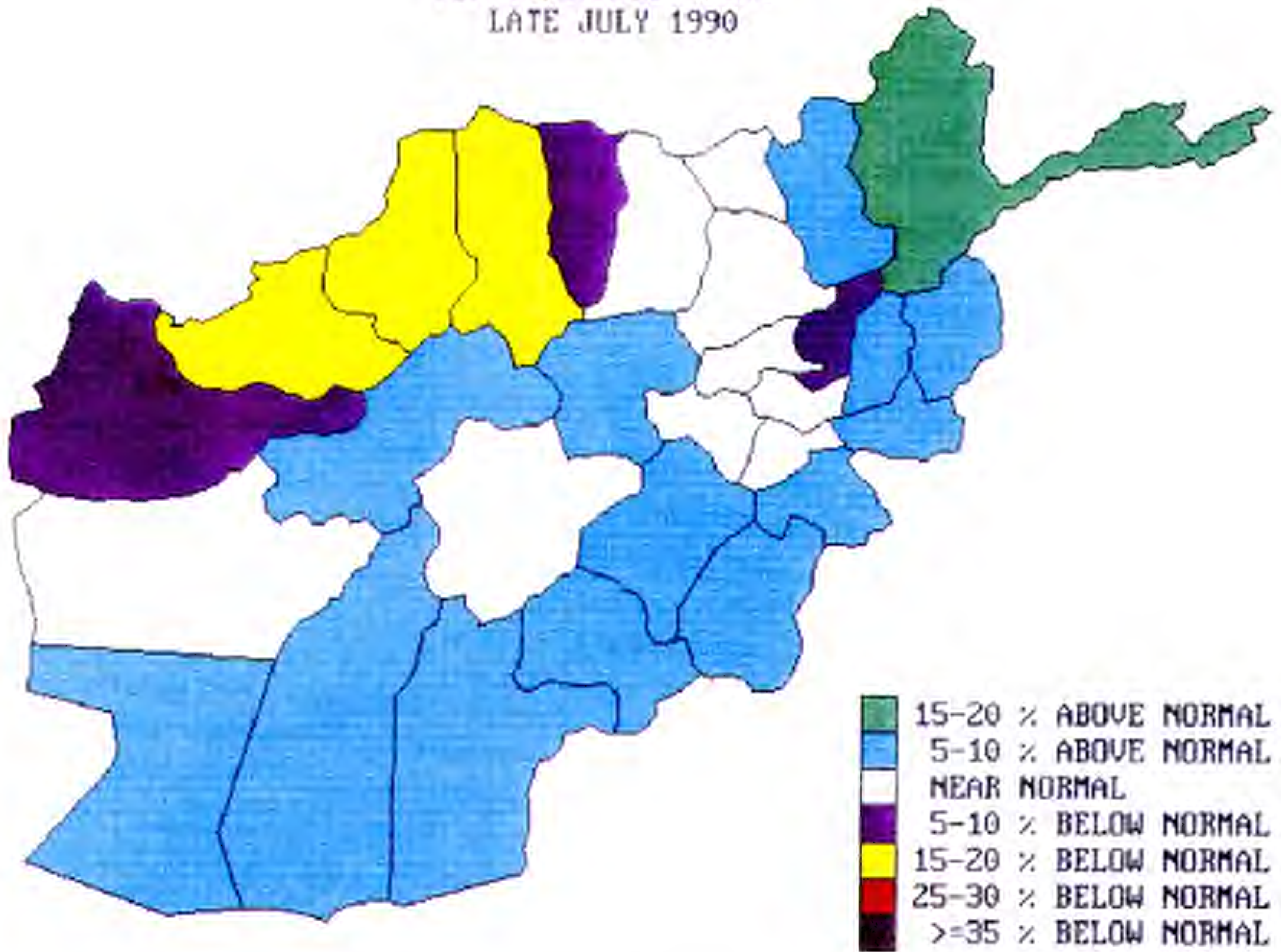
3) Base yields for irrigated wheat average twice the base yields for rainfed wheat for each province.

4) Factors that affect the deviation from base yields are soil type, fertilizer usage, irrigation availability, and environmental factors such as rainfall, evapotranspiration, and pests.

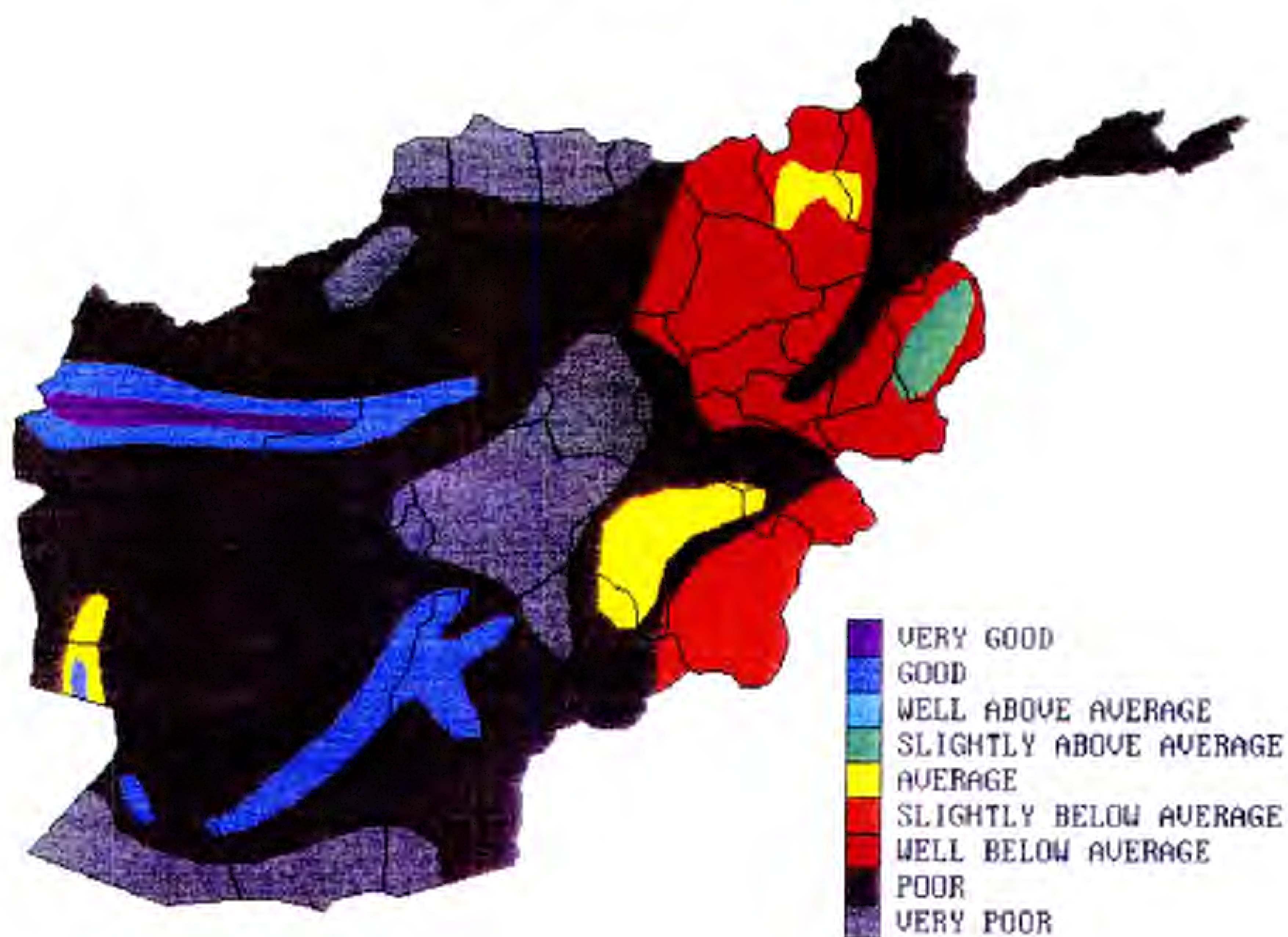
The assumption that there has been no technological trend in yields since 1970 is based on evaluation of the results of existing data sources of national yield and expert opinion obtained in the first phases of the project. Yield data obtained since 1978 was viewed as being of questionable accuracy, and was not used.

The assumption that a normal national base yield is approximately 1250 kilograms per hectare was derived from an analysis of the growing conditions for the period 1973-1978 and reported yields from the Afghan Ministry of Planning and Statistics. Growing conditions during this period were analyzed as being slightly below normal, so the normal yield was above the average yield for the period. We did not use data since 1978 in our analysis because the expert opinion we received advised us to view the post-1978 data as being extremely suspect to large errors.

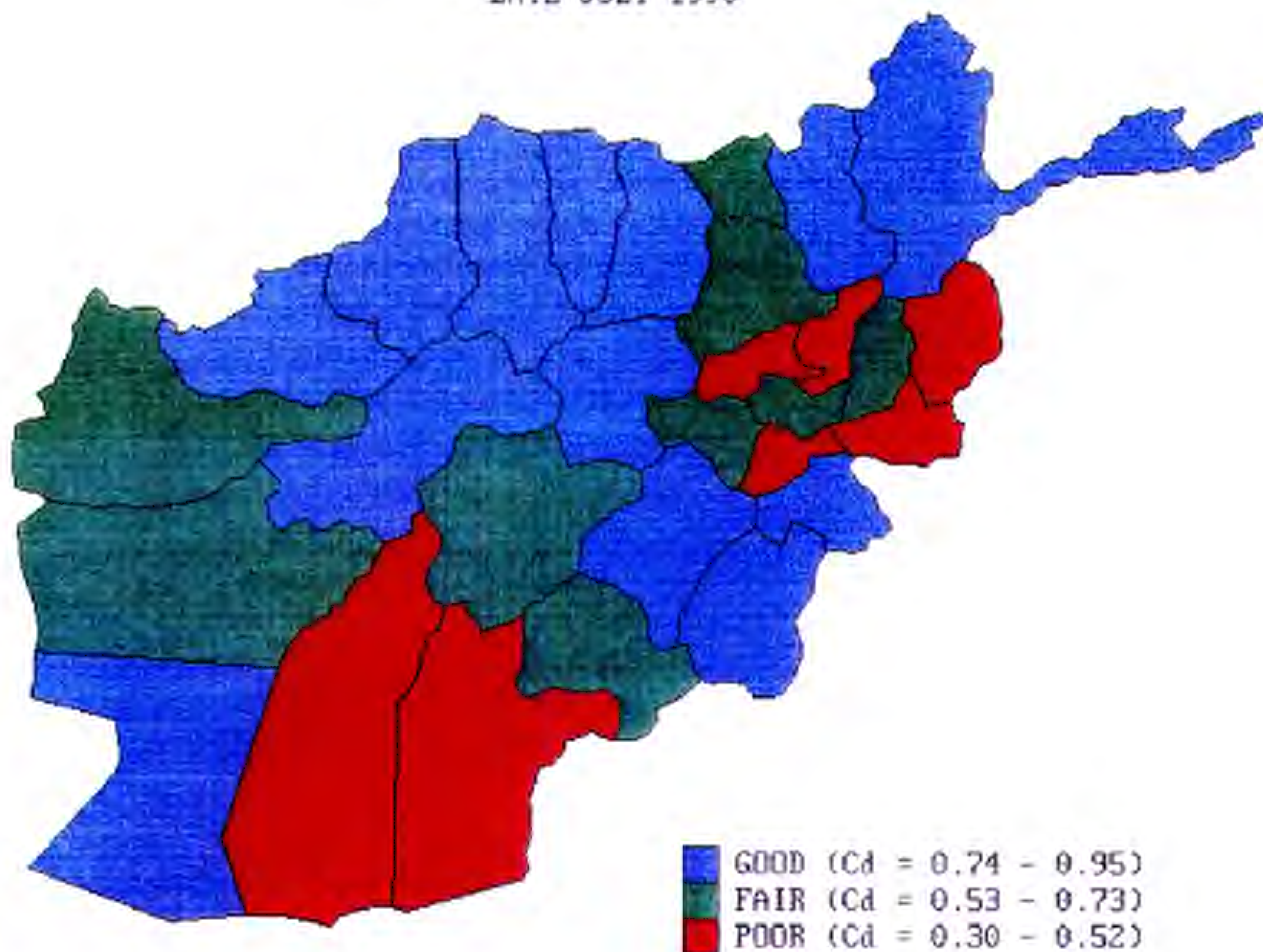
The assumption that base yields for irrigated wheat are two times the yields for rainfed wheat are based on an analysis of data sources obtained from the University of Nebraska, at Omaha, and expert opinion. The Swedish Committee report was also reviewed after this assumption was made. Although we did not use the Swedish yield data in our approach, it did seem to confirm our assumption regarding the yield relationships between irrigated and rainfed wheat.



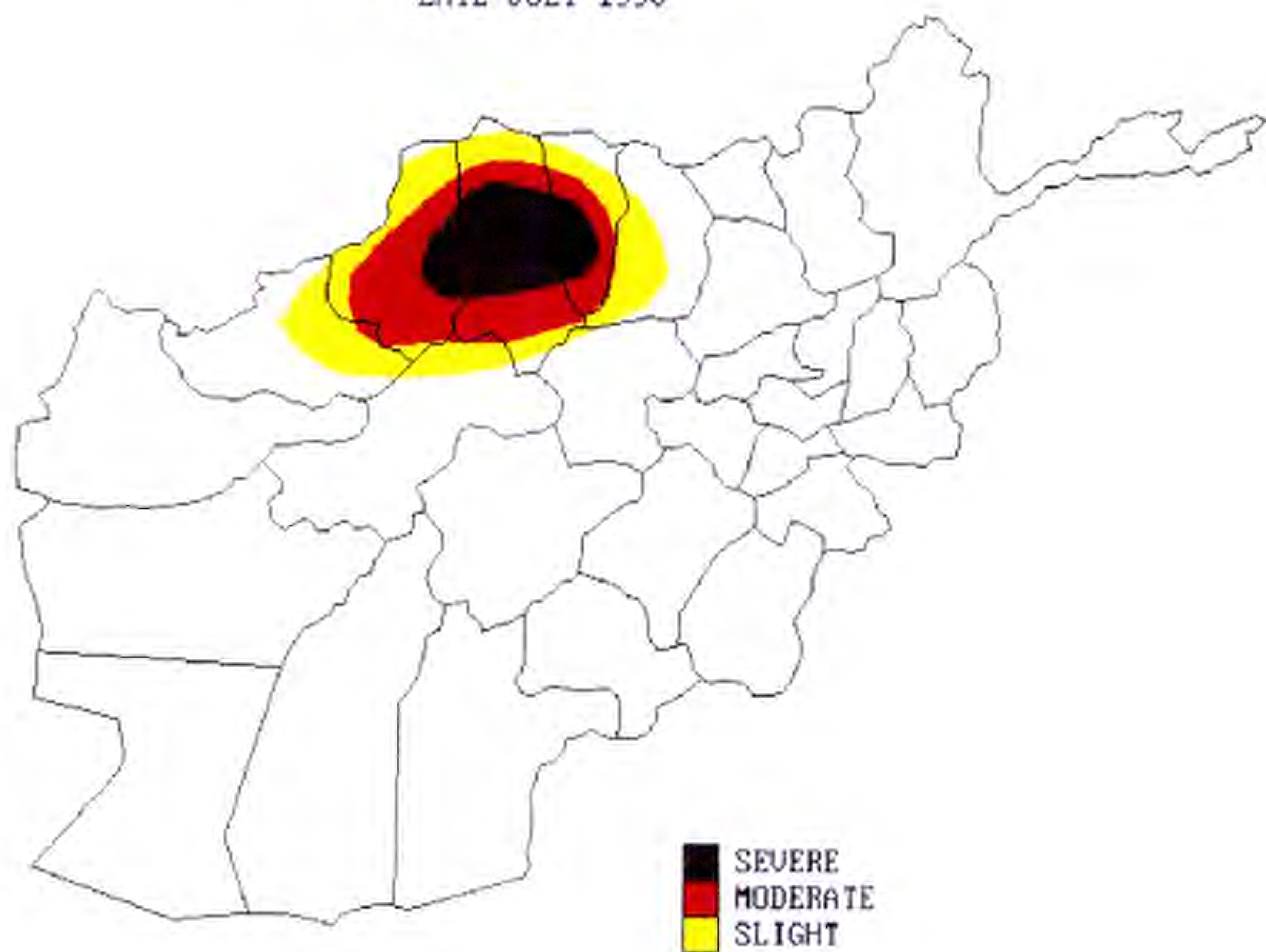

Based on initial CROPCAST modeling estimations. Errors in estimations of +/- 20% possible.



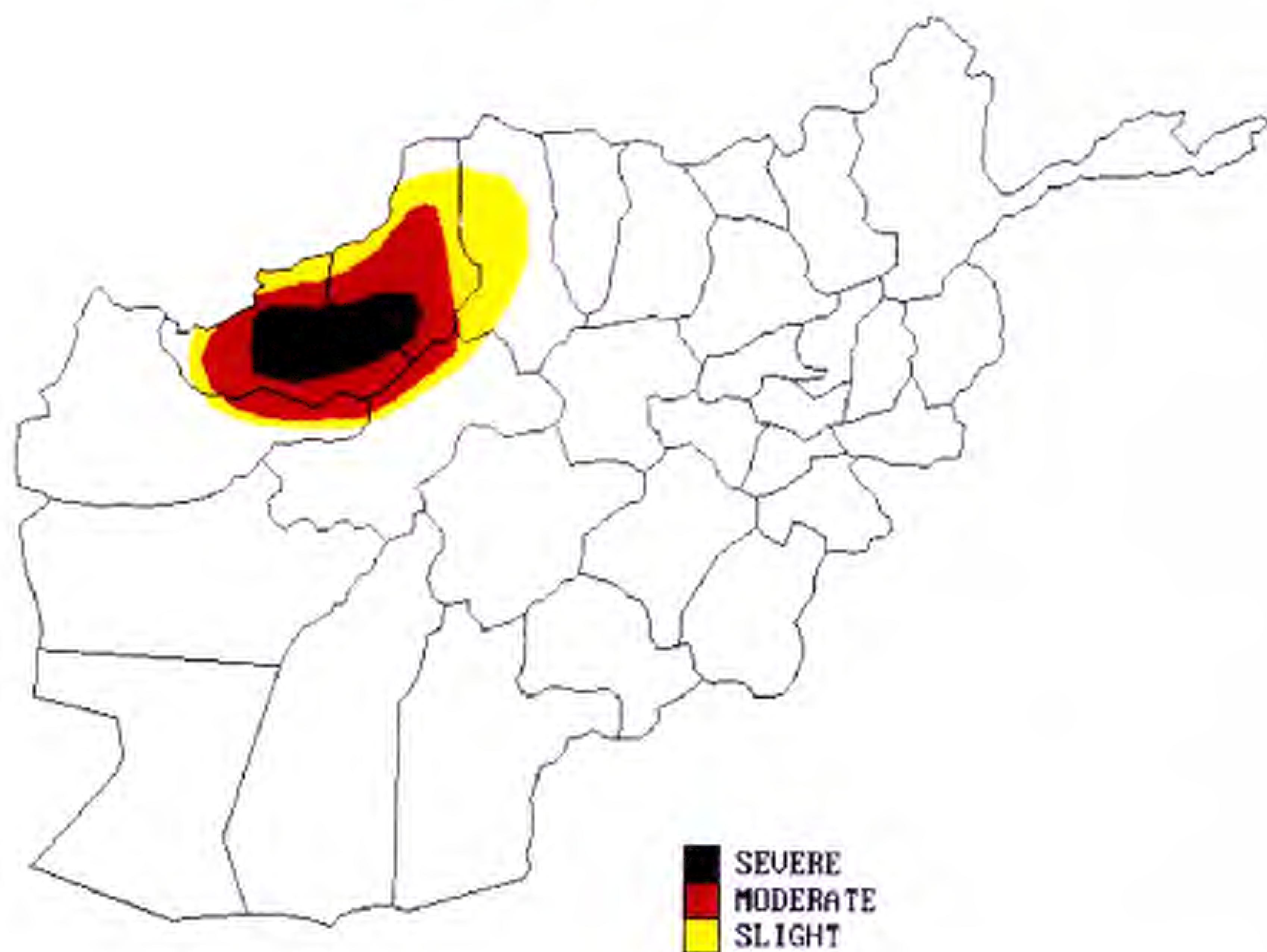

(Geokart 1977)



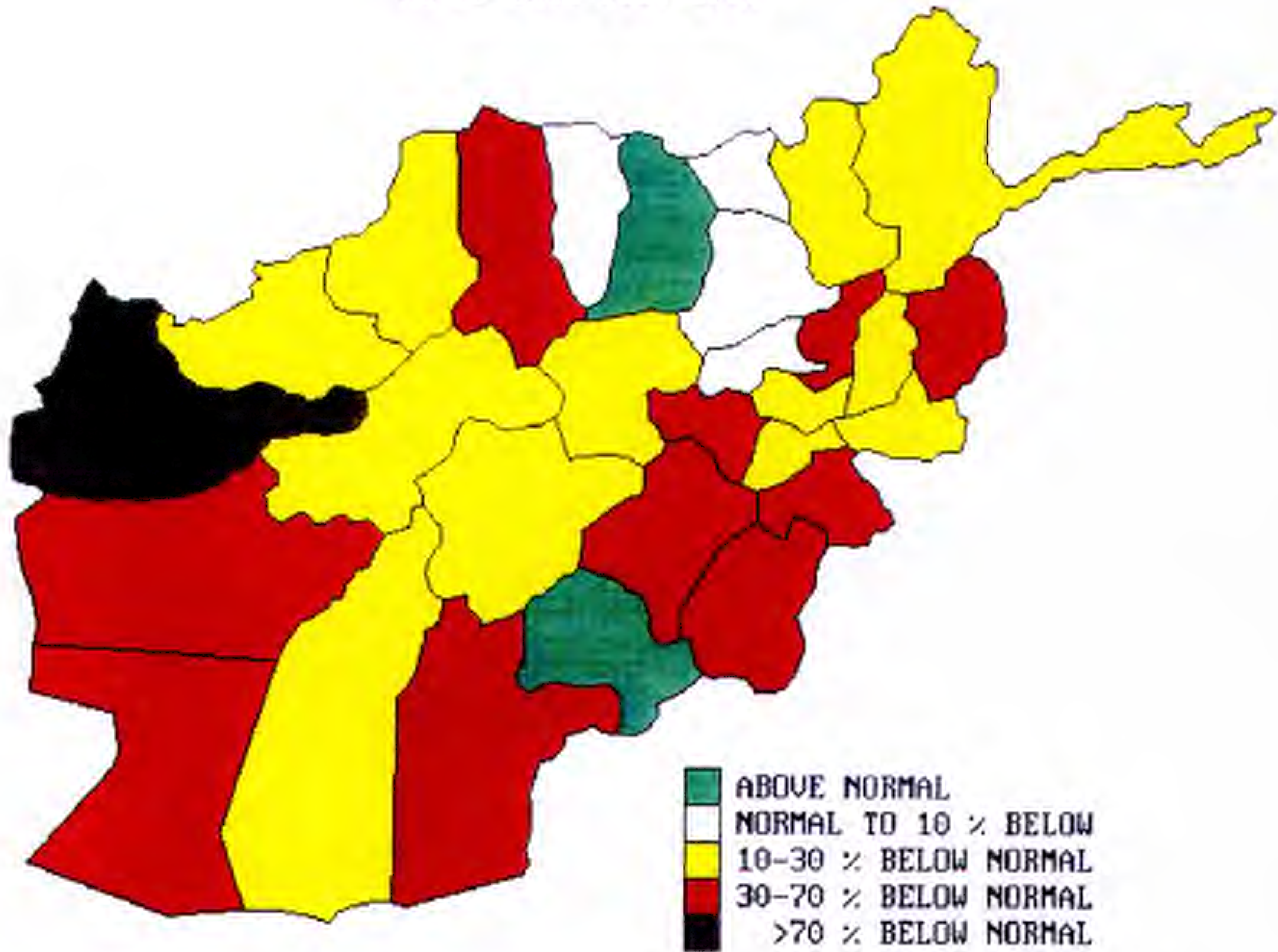

Based on expert opinion.




Based on expert opinion.




Based on expert opinion.




Based on data from Swedish Committee Fourth Report, Fertilizer, denoting percentage change in usage at the province level, between the years 1978 and 1986-87.

# APPENDIX 1

## DISCUSSIONS OF ADJUSTMENTS MADE TO BASE YIELDS BY PROVINCE

# DISCUSSION OF ADJUSTMENTS MADE TO BASE YIELDS BY PROVINCE

## I. WEST REGION

### A. Herat Province

1. This province has approximately 95% (BI = 0.95) of its wheat cropland dedicated to irrigated wheat with 5% (BR = 0.05) dedicated to rainfed. Soils in the province were rated as very good (CFsoil = 0.20), mainly due to the alluvial soils in the Harirud Valley. Fertilizer usage was down considerably in the area with the correction factor rated at CFfert = -0.20. The reduction factor for irrigated wheat was set at (Irf = 0.95) for this year due to the general lack of labor and war damage to the irrigation systems. The reduction factor for rainfed wheat was set at (Rrf = 0.80) to account for the reduced winter snowfall in the mountains and the continuing drought conditions seen throughout the northern section of the country this spring and summer.

2. Province Summary

   (ADJ - 1.0) = (0.20) + (-0.20) + (0.30)
   ADJ = (1.30)
   1250 kg/h * (1.30) = (0.95)*X1 + (0.05)*X2
   X1 = Base Yield for Irrigated Land = 1670 kg/h
   X2 = Base Yield for Rainfed Land = 835 kg/h
   Production = (405,559,500 kg)*(0.95) + (9,936,500 kg)*(0.80)
   Production = 393,231 mt.

## II. NORTHWEST REGION

### A. Badghis Province

1. Only 9% of the available wheat cropland is dedicated to irrigated wheat (BI = 0.09), with rainfed wheat comprising the vast majority of the area planted at 91% (BR = 0.91). Soils in the province are rated as poor due to the sandy mixture with high rates of drainage (CFsoil = -0.15). Fertilizer usage was down slightly in this province, (CFfert = -0.10). The reduction factor for irrigated wheat was set at (Irf = 0.85) to account for labor shortages and reduced winter snowfall. The reduction factor for rainfed wheat was set at (Rrf = 0.60) due to reduced labor, spring and summer drought conditions and severe locust and slight sunn pest infestations.

2. Province Summary

   (ADJ - 1.0) = (-0.15) + (-0.10) + (0.00)
   ADJ = (0.75)
   1250 kg/h * (0.75) = (0.09)X1 + (0.91)X2
   X1 = Base Yield for Irrigated Land = 1720 kg/h
   X2 = Base Yield for Rainfed Land = 860 kg/h
   Production = (11,317,600 kg)*(0.85) + (53,466,200 kg)*(0.60)
   Production = 41,700 mt.

## B. Farayab Province

1. This province is similar to Badghis in that only 8% of the land used for wheat is irrigated (BI = 0.08) while 92% is rainfed (BR = 0.92). Soils in the area are sandy and therefore rated very poor (CFsoil = -0.20). Fertilizer usage was down slightly and was rated as CFfert = -0.10. The reduction factor for irrigated wheat was set at (Irf = 0.80) again due to reduced winter snowfalls and labor shortages. The reduction factor for rainfed wheat was set at (Rrf = 0.50) due to a moderate to severe locust infestation, moderate to severe sunn pest infestation and the general drought conditions in the north.

2. Province Summary

   (ADJ - 1.0) = (-0.20) + (-0.10) +(0.00)
   ADJ = (0.70)
   1250 kg/h * (0.70) = (0.08)X1 + (0.92)X2
   X1 = Base Yield for Irrigated Land = 1620 kg/h
   X2 = Base Yield for Rainfed Land = 810 kg/h
   Production = (20,784,600 kg)*(0.80) + (117,401,400 kg)*(0.50)
   Production = 75,328 mt.

## C. Jowzjan Province

1. This province has slightly more land dedicated to irrigated wheat than the provinces to its west. Irrigated wheat accounts for 20% (BI = 0.20) while rainfed wheat accounts for 80% (BR = 0.80). Soils were rated as poor mainly due to the sandy conditions in the growing regions, (CFsoil = -0.15). Fertilizer usage was down moderately over the entire province and was rated at CFfert = -0.15. The reduction factor for irrigated wheat was set at (Irf = 0.85) due to labor shortages and the continuing drought in the region. The reduction factor for rainfed wheat was set at (Rrf = 0.60) to account for the drought conditions, slight locust infestations and severe sunn pest infestations.

2. Province Summary

   (ADJ - 1.0) = (-0.15) + (-0.20) + (0.00)
   ADJ = (0.70)
   1250 kg/h * (0.70) = (0.20)X1 + (0.80)X2
   X1 = Base Yield for Irrigated Land = 1460 kg/h
   X2 = Base Yield for Rainfed Land = 730 kg/h
   Production = (37,653,400 kg)*(0.85) + (79,270,700 kg)*(0.60)
   Production = 79,568 mt.

## D. Balkh Province

1. Approximately 29% of the agricultural land dedicated to wheat is irrigated (BI = 0.29), with rainfed occupying the remaining 71% (BR = 0.71). Soil was rated as poor, again for the sandy conditions and high drainage rates. Fertilizer usage was rated as only slightly below average, (CFfert = +0.05). The reduction factor for irrigated wheat was set at (Irf = 0.95) due to the slight labor shortages and reduced winter snowfall. The

reduction factor for rainfed wheat was set at (Rrf = 0.90) due to drought conditions and moderate sunn pest infestations.

2. Province Summary

(ADJ - 1.0) = (-0.15) + (+0.05) + (0.00)
ADJ = (0.90)
1250 kg/h * (0.90) = (0.29)X1 + (0.71)X2
X1 = Base Yield for Irrigated Land = 1740 kg/h
X2 = Base Yield for Rainfed Land = 870 kg/h
Production = (89,088,000 kg)*(0.95) + (112,534,500 kg)*(0.90)
Production = 185,915 mt.

### E. Samangan Province

1. This province has the highest percentage of irrigated land in the Northwest Region. Irrigated wheat is grown on 67% (BI = 0.67) of the land dedicated to wheat, while rainfed occupies approximately 33%, (BR = 0.33). Soil was rated as poor for primarily the same reasons given above, (CFsoil = -0.15). Fertilizer usage was rated at slightly above normal (i.e. 1978 levels) as reported by the Swedish Committee Report, (CFfert = +0.10). Both reduction factors for irrigated wheat and rainfed wheat were set at (Irf, Rrf = 1.00) due to increased rainfall over the eastern half of the province in late June and the lack of any widespread crop pest infestations.

2. Province Summary

(ADJ - 1.0) = (-0.15) + (+0.10) + (+0.10)
ADJ = (1.05)
1250 kg/h * (1.05) = (0.67)X1 + (0.33)X2
X1 = Base Yield for Irrigated Land = 1570 kg/h
X2 = Base Yield for Rainfed Land = 785 kg/h
Production = (113,542,400 kg)*(1.00) + (29,029,300 kg)*(1.00)
Production = 142,572 mt.

## III. NORTH REGION

### A. Baghlan Province

1. Irrigated wheat dominates this province covering approximately 85% of the wheat area (BI = 0.85), while rainfed is grown in only 15% (BR = 0.15) of the area. Soils in the province were rated as below average (CFsoil = -0.10) due to small areas of loamy-clay in the south. Fertilizer application was near normal for the eleven year period of 1978-87, (CFfert = +0.05). The reduction factors for irrigated and rainfed wheat were set at (Irf, Rrf = 1.00) due to the near normal precipitation during the spring and summer and the lack of any significant crop pests.

Our assumptions on the parameters used for adjusting the base yields were based on the experience of the CROPCAST modelers in similar growing regions and expert opinions as to the critical factors causing yield deviations in Afghan wheat agriculture.

The equations employed for the calculation of the base yields are:

```
Total Production = Aiw * (X1*Irf) + Arw * (X2*Rrf)

Base Yield * ADJ = (BI * X1) + (BR * X2)
X1 = 2.0 * X2
```

Where:

| | | |
|---|---|---|
| Base Yield | = | 1250 kg/h |
| ADJ | = | (CFsoil + CFfert + CF%irr) + 1.0 |
| CFsoil | = | Correction factor for soil type |
| CFfert | = | Correction factor for fertilizer availability |
| CF%irr | = | Correction factor for percentage of irrigated land |
| Aiw | = | Irrigated wheat area |
| Arw | = | Rainfed wheat area |
| Irf | = | Reduction factor for irrigated wheat |
| Rrf | = | Reduction factor for rainfed wheat |
| BI | = | Percentage of irrigated acreage |
| BR | = | Percentage of rainfed acreage |
| X1 | = | Adjusted base yield for irrigated wheat |
| X2 | = | Adjusted base yield for rainfed wheat. |

The correction factors (CF's) used in the calculation of the adjustment (ADJ) to the base yields required, are defined as follows:

| | | |
|---|---|---|
| CFsoil= | +0.20 | Very Good soils |
| | +0.15 | Good soils |
| | +0.10 | Above Average + |
| | +0.05 | Above Average - |
| | 0.00 | Average |
| | -0.05 | Below Average + |
| | -0.10 | Below Average - |
| | -0.15 | Poor soils |
| | -0.20 | Very poor soils present |
| CFfert= | +0.10 | Above normal usage |
| | +0.05 | Normal/(<10% below normal) |
| | -0.10 | 10 - 30% Below normal |
| | -0.15 | 31 - 70% Below normal |
| | -0.20 | 71 - 100% Below normal |
| CF%irr= | 0.00 | <= 50% Irrigated land |
| | +0.10 | 51 - 75% Irrigated land |
| | +0.20 | 76 - 90% Irrigated land |
| | +0.30 | 91 - 100% Irrigated land |

2. Province Summary

(ADJ - 1.0) = (-0.10) + (+0.05) + (+0.20)
ADJ = (1.15)
1250 kg/h * (1.15) = (0.85)X1 + (0.15)X2
X1 = Base Yield for Irrigated Land = 1560 kg/h
X2 = Base Yield for Rainfed Land = 780 kg/h
Production = (115,486,800 kg)*(1.00) + (10,264,800 kg)*(1.00)
Production = 125,752 mt.

**B. Kunduz Province**

1. This province has approximately 78% of its wheat land dedicated to irrigated wheat (BI = 0.78) and 22% to rainfed (BR = 0.22). Soils were rated as below average (CFsoil = -0.10), although there are some loamy-clay soils along the Oonduz River. Fertilizer usage in the area was only slightly below average and consequently received a rating of CFfert = +0.05. The reduction factors for both crops were set at (Irf, Rrf = 1.00) due to similar conditions experienced in Baghlan.

2. Province Summary

(ADJ - 1.0) = (-0.10) + (+0.05) + (+0.20)
ADJ = (1.15)
1250 kg/h * (1.15) = (0.78)X1 + (0.22)X2
X1 = Base Yield for Irrigated Land = 1620 kg/h
X2 = Base Yield for Rainfed Land = 810 kg/h
Production = (165,240,000 kg)*(1.00) + (20,233,800 kg)*(1.00)
Production = 185,915 mt.

**C. Takhar Province**

1. This province is situated further into the northeastern Hindu Kush range and has more of a balance between irrigated and rainfed wheat areas. Irrigated wheat accounts for 53% (BI = 0.53) of the available wheat areas while rainfed comprises the remaining 47% (BR = 0.47). Soils in the area were rated as average due to the loam and alluvial soils in the Kowkcheh River Valley (CFsoil = +0.00). Fetilizer usage was down 20% warranting a rating of CFfert = -0.15. The reduction factors for irrigated and rainfed wheat were set at (Irf, Rrf = 1.05) due to adequate rainfall and near normal temperatures.

2. Province Summary

(ADJ - 1.0) = (0.00) + (-0.10) + (+0.10)
ADJ = (1.00)
1250 kg/h * (1.00) = (0.53)X1 + (0.47)X2
X1 = Base Yield for Irrigated Land = 1630 kg/h
X2 = Base Yield for Rainfed Land = 815 kg/h
Production = (202,853,500 kg)*(1.05) + (91,565,250 kg)*(1.05)
Production = 309,140 mt.

## IV. NORTHEAST REGION

### A. Badakhshan Province

1. Large scale farming in the province is restricted to the Kowckcheh River Valley, where 47% of the wheat land is dedicated to irrigated wheat (BI = 0.47). Several small scale farms are located in the south along the Takhar border where 59% of the wheat is rainfed (BR = 0.59). Soils in the area were rated as poor due to the rocky, clay conditions in the south and east (CFsoil = -0.15). Fertilizer usage was down slightly (CFfert -0.10), although due to the high percentage of rainfed crop, probably did not effect province yields considerably. The reduction factor for irrigated wheat was set at (Irf = 1.15) to account for the increased rainfall and adequate snowfall the previous winter. The reduction factor for rainfed wheat was set at (Rrf = 1.20) due to the increased rainfall and lack of crop pests.

2. Province Summary

   (ADJ - 1.0) = (-0.15) + (-0.10) + (0.00)
   ADJ = (0.75)
   1250 kg/h * (0.75) = (0.47)X1 + (0.53)X2
   X1 = Base Yield for Irrigated Land = 1330 kg/h
   X2 = Base Yield for Ranifed Land = 665 kg/h
   Production = (49,422,800 kg)*(1.15) + (36,069,600 kg)*(1.20)
   Production = 100,094 mt.

## V. CENTRAL REGION

### A. Bamyan Province

1. Irrigated wheat comprises 81 % of the total wheat area in this province (BI = 0.81) with rainfed occupying the remaining 19% (BR = 0.19). Soils were rated as very poor for this province due to its mountainous location and rocky, clay soils, (CFsoil = -0.20). Fertilizer usage was moderately below normal warranting a rating of CFfert = -0.10. The reduction factor for irrigated wheat in this province was set at (Irf = 1.10) due to the adequate rainfall in late spring and near normal rainfall through June, lack of widespread war damage to irrigation systems and the slight reduction in labor. The reduction factor for rainfed wheat was set at (Rrf = 1.20) again for the adequate rainfall and resumption of near normal farming practices.

2. Province Summary

   (ADJ - 1.0) = (-0.20) + (-0.10) + (+0.20)
   ADJ = (0.90)
   1250 kg/h * (0.90) = (0.81)X1 + (0.19)X2
   X1 = Base Yield for Irrigated Land = 1240 kg/h
   X2 = Base Yield for Rainfed Land = 620 kg/h
   Production = (21,352,800 kg)*(1.10) + (2,492,400 kg)*(1.20)
   Production = 26,479 mt.

B. **Ghor Province**

1. Approximately 66% of the total wheat area in this province is dedicated to irrigated wheat (BI = 0.66) with rainfed comprising 34% of the area (BR = 0.34). Soils in the province were rated as poor (CFsoil = -0.15), again due to the mountainous terrain. Fertilizer usage was down moderately with a rating of CFfert = -0.10. The reduction factor for irrigated wheat was set at (Irf = 1.05) due to similar reasoning given for Bamyan. The reduction factor for rainfed wheat was set at (Rrf = 1.10) due to slight above normal rainfall and temperatures.

2. Province Summary

(ADJ - 1.0) = (-0.15) + (-0.10) + (+0.10)
ADJ = (0.85)
1250 kg/h * (0.85) = (0.66)X1 + (0.34)X2
X1 = Base Yield for Irrigated Land = 1280 kg/h
X2 = Base Yield for Rainfed Land = 640 kg/h
Production = (90,636,800 kg)*(1.05) + (23,852,800 kg)*(1.10)
Production = 121,407 mt.

VI. **EAST CENTRAL REGION**

A. **Parwan Province**

1. This province is dominated by irrigated wheat at 94% (BI = 0.94) while rainfed comprises the remaining 6% (BR = 0.06). Soil conditions were rated as below average due to the mostly clay and loamy-clay conditions, (CFsoil = -0.10). Fertilizer usage remained fairly stable, according to the Swedish Committee Report, therefore the fertilizer correction factor was set at CFfert = +0.05. The reduction factor for irrigated wheat was set at (Irf = 1.00) due to near normal conditions in precipitation and temperature and the lack of widespread reported damage to irrigation systems. The reduction factor for rainfed wheat was set at (Rrf = 0.95) again due to the near normal weather conditions.

2. Province Summary

(ADJ - 1.0) = (-0.10) + (+0.05) + (+0.30)
ADJ = (1.25)
1250 kg/h * (1.25) = (0.94)X1 + (0.06)X2
X1 = Base Yield for Irrigated Land = 1610 kg/h
X2 = Base Yield for Rainfed Land = 805 kg/h
Production = (17,404,100 kg)*(1.00) + (515,200 kg)*(0.95)
Production = 17,894 mt.

B. **Kapisa Province**

1. According to known sources, essentially all of the wheat grown as a cash crop in the province is on some form of irrigated land, (BI = 1.00, BR = 0.00). Soils were rated as below average due to the mountainous conditions, (CFsoil = -0.10). Fertilizer usage

was down moderately as was the case for most provinces in the area, (CFfert = -0.15). The reduction factor for irrigated wheat was set at (Irf = 0.95) due to slightly below normal rainfall as well as for only a moderate decline in labor. The reduction factor for rainfed wheat was set at (Rrf = 0.85) to account for the reduction in rainfall and labor shortage.

2. Province Summary

(ADJ - 1.0) = (-0.10) + (-0.15) + (+0.30)
ADJ = (1.05)
1250 kg/h * (1.05) = (1.00)X1 + (0.00)X2
X1 = Base Yield for Irrigated Land = 1310 kg/h
X2 = Base Yield for Rainfed Land = 655 kg/h
Production = (20,501,500 kg)*(0.95) + (0.00)*(0.85)
Production = 19,476 mt.

## C. Laghman Province

1. Irrigated wheat comprises a large percentage of the wheat area in this province also. Approximately 96% (BI = 0.96) of the wheat area is irrigated with 4% (BR = 0.04) dedicated to the rainfed crop. Soil conditions are similar to those in Kapisa and are rated as poor (CFsoil = -0.15). Fertilizer usage in the province was rated as moderately below normal warranting a rating of CFfert = -0.10. The reduction factor for irrigated wheat was set at (Irf = 1.05) due to only slight disruption of irrigation systems and near normal weather conditions. The reduction factor for rainfed wheat was set at (Rrf = 1.10) due to near normal weather conditions and some resumption of normal farming practices.

2. Province Summary

(ADJ - 1.0) = (-0.15) + (-0.10) + (+0.30)
ADJ = (1.05)
1250 kg/h * (1.05) = (0.96)X1 + (0.04)X2
X1 = Base Yield for Irrigated Land = 1340 kg/h
X2 = Base Yield for Rainfed Land = 770 kg/h
Production = (19,416,600 kg)*(1.05) + (438,900 kg)*(1.10)
Production = 20,808 mt.

## D. Kabul Province

1. Irrigated wheat is grown on 94% of the wheat area in this province (BI = 0.94) with rainfed occupying the remaining 6% (BR = 0.06). Soil conditions in the province were rated as poor (CFsoil = -0.15) due to the rocky, clay soil in the north and west. Fertilizer applications were down slightly over the entire province (CFfert = -0.10). The reduction factors for both crops was set at (Irf, Rrf = 1.00) due to the normal precipitation and temperatures experienced by this province in the spring and summer.

2. Province Summary

(ADJ - 1.0) = (-0.15) + (-0.10) + (+0.30)
ADJ = (1.05)
1250 kg/h * (1.05) = (0.94)X1 + (0.06)X2
X1 = Base Yield for Irrigated Land = 1350 kg/h
X2 = Base Yield for Rainfed Land = 675 kg/h
Production = (38,853,000 kg)*(1.00) + (1,059,750 kg)*(1.00)
Production = 39,913 mt.

## E. Wardak Province

1. According to the best available information, the entire cash wheat crop in this province was determined to be irrigated wheat (BI = 1.00, BR = 0.00). Soil conditions are similar to those in the other Central Region provinces and was rated as below average, (CFsoil = -0.10). Fertilizer usage was down moderately in the area warranting a rating of CFfert = -0.15. The reduction factors for irrigated and rainfed wheat were set at (Irf, Rrf = 1.000 due to the same weather conditions prevalent in Kabul province.

2. Province Summary

(ADJ - 1.0) = (-0.10) + (-0.15) + (+0.30)
ADJ = (1.05)
1250 kg/h * (1.05) = (1.00)X1 + (0.00)X2
X1 = Base Yield for Irrigated Land = 1310 kg/h
X2 = Base Yield for Rainfed Land = 655 kg/h
Production = (17,475,400 kg)*(1.00) + (0.00)*(1.00)
Production = 17,475 mt.

## F. Lowgar Province

1. This province has approximately 92% of its available wheat cropland dedicated to irrigated wheat (BI = 0.92) and the remaining 8% to rainfed wheat (BR = 0.08). Soil conditions in this southernmost province of the Central Region were rated as below average (CFsoil = -0.10) due to some loam areas mixed in with the rocky, clay condiitons found elsewhere in the region. Fertilizer usage in the province was down slightly from 1978 levels, with an assigned correction factor of CFfert = -0.10. The reduction factors for both crops were set at (Irf, Rrf = 1.00) again due to the same weather conditions prevailing in the surrounding provinces.

2. Province Summary

(ADJ - 1.0) = (-0.10) + (-0.10) + (+0.30)
ADJ = (1.10)
1250 kg/h * (1.10) = (0.92)X1 + (0.08)X2
X1 = Base Yield for Irrigated Land = 1430 kg/h
X2 = Base Yield for Rainfed Land = 715 kg/h
Production = (7,450,300 kg)*(1.00) + (293,150 kg)*(1.00)
Production = 7,743 mt.

VII. NORTH CENTRAL REGION

A. **Uruzghan Province**

1. Irrigated wheat is grown on 86% of the wheat cropland (BI = 0.86) with rainfed wheat on the remaining 14% (BR = 0.14). Soils were rated very poor in this area (CFsoil = -0.20) due to the extreme mountainous terrain and rocky, clay soils over the entire northern three-quarters of the province. Fertilizer usage was rated at CFfert = -0.10) due to the moderate decline in application since 1978. The reduction factors for both irrigated and rainfed wheat were set at (Irf, Rrf = 1.00) due to normal rainfall and temperatures and only slight disruptions in agriculture due to the war.

2. Province Summary

(ADJ - 1.0) = (-0.20) + (-0.10) + (+0.20)
ADJ = (0.90)
1250 kg/h * (0.90) = (0.86)X1 + (0.14)X2
X1 = Base Yield for Irrigated Land = 1210 kg/h
X2 = Base Yield for Rainfed Land = 605 kg/h
Production = (71,111,700 kg)*(1.00) + (5,445,000 kg)*(1.00)
Production = 76,557 mt.

B. **Ghazni Province**

1. This province is the main irigated wheat producer in the Region. Approximately 94% of the wheat crop is dedicated to irrigated (BI = 0.94) with rainfed comprising the remaining 6% (BR = 0.06). Soil conditions were rated as average due to the small but significant areas of alluvial soils in the Putay Shelah and Rowd-e Lurah river valleys, (CFsoil = 0.00). Fertilizer usage was down moderately throughout the province with an assigned correction factor of CFfert = -0.15. The reduction factor for irrigated wheat was set at (Irf = 1.05) due to the adequate rainfall in the spring and the reported repair of some key irrigation systems. The reduction factor for rainfed wheat was set at (Rrf = 1.10) due to the conditions described above.

2. Province Summary

(ADJ - 1.0) = (0.00) + (-0.15) + (+0.30)
ADJ = (1.15)
1250 kg/h * (1.15) = (0.94)X1 + (0.06)X2
X1 = Base Yield for Irrigated Land = 1480 kg/h
X2 = Base Yield for Rainfed Land = 740 kg/h
Production = (141,354,800 kg)*(1.05) + (4,121,800 kg)*(1.10)
Production = 152,957 mt.

C. **Zabul Province**

1. This province's wheat crop is comprised of 90% irrigated wheat (BI = 0.90) and 10% rainfed wheat (BR = 0.10). Soil conditions were rated as very poor (CFsoil = -0.20) due to the rocky, clay conditions in the northwest half of the province. Fertilizer usage

was reported as down slightly, with a rating of CFfert = +0.10. The reduction factors for irrigated wheat and rainfed wheat were set at those representative of Ghazni (Irf = 1.05, Rrf = 1.10) due to similar conditions occuring in these two provinces.

2. Province Summary

(ADJ - 1.0) = (-0.20) + (+0.10) + (+0.30)
ADJ = (1.20)
1250 kg/h * (1.20) = (0.90)X1 + (0.10)X2
X1 = Base Yield for Irrigated Land = 1580 kg/h
X2 = Base Yield for Rainfed Land = 790 kg/h
Production = (66,723,400 kg)*(1.05) + (3,318,000 kg)*(1.10)
Production = 73,709 mt.

# VIII. EAST REGION

## A. Ninghrehar Province

1. Approximately 86% of the wheat cropland in this province is dedicated to irrigated wheat (BI = 0.86) with the remaining 14% grown as rainfed wheat (BR = 0.14). Soil conditions were rated as below average (CFsoil = -0.10) due to the clay soils in the north, although good alluvial loams could be found in the Kabul River Valley. Fertilizer usage was down slight to moderate over the entire province with a rating of CFfert = -0.10. The reduction factor for irrigated wheat was set at (Irf = 1.05) due to near normal precipitation and no widespread crop pest infestations. The reduction factor for rainfed wheat was set at (Rrf = 1.10) due to normal temperatures in the province and near normal precipitation in the east.

2. Province Summary

(ADJ - 1.0) = (-0.10) + (-0.10) + (+0.20)
ADJ = (1.00)
1250 kg/h * (1.00) = (0.86)X1 + (0.14)X2
X1 = Base Yield for Irrigated Land = 1340 kg/h
X2 = Base Yield for Rainfed Land = 670 kg/h
Production = (35,335,800 kg)*(1.05) + (2,733,600 kg)*(1.10)
Production = 40,110 mt.

## B. Kunar Province

1. This province is comprised of 83% irrigated wheat (BI = 0.83) with 17% dedicated to rainfed wheat (BR = 0.17). Soils in the area were rated at slightly above average (CFsoil = +0.05) due to the forest-type loams found in the growing regions along the Pakistan border. Fertilizer usage was reported as down moderately, therefore a rating of CFfert = -0.15 was assigned. The reduction factor for irrigated wheat was set at (Irf = 1.10) due to the adequate precipitation during the spring and early summer and the generally widespread damage to irrigation systems. The reduction factor for rainfed wheat was set at (Rrf = 1.20) to account for the sufficient moisture and normal temperatures thoughout the early part of the growing season.

2. Province Summary

(ADJ - 1.0) = (+0.05) + (-0.15) + (+0.20)
ADJ = (1.10)
1250 kg/h * (1.10) = (0.83)X1 + (0.17)X2
X1 = Base Yield for Irrigated Land = 1500 kg/h
X2 = Base Yield for Rainfed Land = 750 kg/h
Production = (9,825,000 kg)*(1.10) + (982,500 kg)*(1.20)
Production = 11,987 mt.

### C. Paktia/Paktika Provinces

1. These two provinces are combined as one unit for this report based on the reasons provided in the report on area calculation coefficients. The combined province breakdown on the wheat crop is 91% irrigated wheat (BI = 0.91) and 9% rainfed wheat (BR = 0.09). Soils were rated slightly below average (CFsoil = -0.05) due to the clay soils in the southeast, although some forest-type loams are found in the north central areas. Fertilizer usage was down moderately (CFfert = -0.15). The reduction factor for irrigated wheat was set at (Irf = 1.05) due to the near normal precipitation and temperature experienced over the area. The reduction factor for rainfed wheat was set at (Rrf = 1.10) to account for the normal weather conditions as well as the moderate war damage to agriculture that is now beginning to be repaired.

2. Province Summary

(ADJ - 1.0) = (-0.05) + (-0.15) + (+0.30)
ADJ = (1.10)
1250 kg/h * (1.10) = (0.91)X1 + (0.09)X2
X1 = Base Yield for Irrigated Land = 1440 kg/h
X2 = Base Yield for Rainfed Land = 720 kg/h
Production = (68,918,400 kg)*(1.05) + (3,254,400 kg)*(1.10)
Production = 75,944 mt.

## IX. SOUTHWEST REGION

### A. Kandahar Province

1. This province is comprised of 97% irrigated wheat (BI =0.97) and 3% rainfed wheat (BR = 0.03). Soils in the region were rated as good (CFsoil +0.15), primarily due to the alluvial loams in the main growing regions adjacent to the Helmand River and Arghadab Reservoir. Fertilizer usage was down moderately from 1978 levels (CFfert = -0.15). The reduction factor for irrigated wheat was set at (Irf = 1.10) to account for small scale efforts to improve war damaged irrigation systems as well as favorable weather conditions in the spring and early summer. The reduction factor for rainfed wheat was set at (Rrf = 1.20) due to the normal to slightly above normal rainfall and temperatures in the spring.

2. Province Summary

(ADJ - 1.0) = (+0.15) + (-0.15) + (+0.30)
ADJ = (1.30)
1250 kg/h * (1.30) = (0.97)X1 + (0.03)X2
X1 = Base Yield for Irrigated Land = 1650 kg/h
X2 = Base Yield for Rainfed Land = 825 kg/h
Production = (48,180,000 kg)*(1.10) + (557,500 kg)*(1.20)
Production = 53,691 mt.

## B. Helmand Province

1. This province is very similar to Kandahar in the three categories presented here. Approximately 83% of the wheat cropland is grown as irrigated wheat (BI = 0.83) with the remaining 17% going to rainfed wheat (BR = 0.17). Soil conditions were rated as good (CFsoil = +0.15), for the productive alluvial loams along the Helmand River. Fertilizer usage was reported down slightly with a correction factor rating of CFfert = -0.10. The reduction factor for irrigated wheat was set at (Irf = 1.05) due to only slight damage to agriculture, although more serious damage and neglect of irrigation systems are assumed being repaired. The reduction factor for rainfed wheat was set at (Rrf = 1.10) due to slightly below normal rainfall in the spring and near normal temperatures.

2. Province Summary

(ADJ - 1.0) = (+0.15) + (-0.10) + (+0.20)
ADJ = (1.25)
1250 kg/h * (1.25) = (0.83)X1 + (0.17)X2
X1 = Base Yield for Irrigated Land = 1710 kg/h
X2 = Base Yield for Rainfed Land = 855 kg/h
Production = (41,108,400 kg)*(1.05) + (3,950,100 kg)*(1.10)
Production = 47,509 mt.

## C. Farah Province

1. Again, according to reported figures, essentially all the cash crop wheat grown in the province is irrigated wheat (BI = 1.00, BR = 0.00). Soil conditions were rated as poor (CFsoil = -0.15) due to the sandy/saline soils in the southwest areas of the province and the sandy soils in the north. Fertilizer usage was down moderately, warranting a rating of CFfert = -0.15. The reduction factor for irrigated wheat was set at (Irf = 1.00) due to slight to moderate damage to irrigation systems and very little damage to agriculture as a whole. The reduction factor for rainfed wheat was set at (Rrf = 1.00) due to normal precipitation and temperatures in the spring.

2. Province Summary

(ADJ - 1.0) = (-0.15) + (-0.15) + (+0.30)
ADJ = (1.00)
1250 kg/h * (1.00) = (1.00)X1 + (0.00)X2
X1 = Base Yield for Irrigated Land = 1250 kg/h
X2 = Base Yield for Rainfed Land = 625 kg/h
Production = (88,787,500 kg)*(1.00) + (0.00 kg)*(1.00)
Production = 88,788 mt.

## D. Nimruz Province

1. This province's wheat crop is also essentially entirely dedicated to irrigated wheat (BI = 1.00, BR = 0.00). Soil conditions were rated as poor (CFsoil = -0.15), for the sandy and saline soils present in the southwest, although productive alluvial loams are found immediately adjacent to the Helmand River. Fertilizer usage was down considerably across the province with an assigned rating of CFfert = -0.15. The reduction factor for irrigated wheat and rainfed wheat were set at (Irf = 1.05) due to similar conditions which prevail in Helmand, although war damage to irrigation systems in Nimruz and damage to agriculture as a whole is reported to be less severe than in Helmand.

2. Province Summary

(ADJ - 1.0) = (-0.15) + (-0.15) + (+0.30)
ADJ = (1.00)
1250 kg/h * (1.00) = (1.00)X1 + (0.00)X2
X1 = Base Yield for Irrigated Land = 1250 kg/h
X2 = Base Yield for Rainfed Land = 625 kg/h
Production = (154,250,000 kg)*(1.05) + (0.00 kg)*(1.10)
Production = 161,963 mt.

The assumptions made in defining these criteria were that "good" natural soils and application of fertilizer would necessarily produce increased yield in the crop grown. The correction factor for percent of irrigated land (CF%irr) was employed to minimize the effect to base yield that weather related stresses, (i.e. drought, high temperatures, pests, etc.) have in areas with a large percentage of irrigated land as opposed to areas with a large percentage of rainfed land, (i.e. weather stresses have a greater adverse effect on rainfed crops than irrigated crops).

From the set of correction factors a provincial base yield for irrigated and rainfed wheat was computed to provide an estimate of the crop yield for a "normal year". The provincial base yields were themselves modified according to sets of reduction factors in order to obtain initial yield estimates for the year 1990.

The individual correction factors employed in the calculation of provincial base yields were obtained from both historical data and expert opinion. The correction factor for fertilizer usage was determined from data published by the Swedish Committee for Afghanistan's Fourth Report, Fertilizer, which outlined the relative percentages of fertilizer usage by province. Where applicable, expert opinion was again used to account for current changes in fertilizer usage not reflected in the data. The correction factor for percentage of irrigated land, was based wholly on the initial acreage estimates for irrigated and rainfed wheat outlined in Section 2.0 below.

The crop reduction factors were employed to account for current stresses imposed on the growing crop, (i.e. excessive heat, drought, insect/microbiotic pests, labor shortages, etc.). Determination of these factors was carried out according to the basic CROPCAST modeling approach.

# APPENDIX 2

## CALCULATIONS OF COEFFICIENTS OF AREA OF WHEAT BY PROVINCE

# CALCULATIONS OF COEFFICIENTS OF AREA OF WHEAT BY PROVINCE

## ALL HECTARAGES ARE ROUNDED TO THE NEAREST 10 HA

I. WEST REGION

A. **Herat Province**

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 476,170 ha (Afghan Gov't statistics)

b. Dominance of Irrigated Wheat: Almost all of the province is within the area described by Dr. Wakil as being irrigation-dominated. The Swedish Committee reports total farm area as being almost equal in area for irrigated and rainfed. However, while from 80 to 100% of farmers surveyed grew irrigated wheat, only 15-20% grew rainfed wheat. Thus, we will reduce the coefficient of irrigated wheat dominance from 90% to 85% to account for these rainfed areas.

$C_W$ = 0.85

c. Irrigation Damage or Abandonment: Dr. Wakil rated Herat as a moderately war-damaged and irrigation-depleted province.

$C_D$ = 0.60

d. Competing Crops: Herat is not included in the areas with a high degree of poppy cultivation.

$C_C$ = 1.00

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 476,170 ha (Afghan Gov't statistics)

b. Dominance of Rainfed Wheat: Using the discussion above, rainfed wheat accounts for about 5% of the total annual crop area.

$C_{RW}$ = 0.05

c. Other reported area reduction: although Herat city received heavy war damage, no significant area reduction cause for rainfed wheat was described. Many sources state that about 1/3 of all rainfed area lies fallow each year. The Swedish committee reports rainfed wheat area fell by 20 to 54% between 1978 and 1987. If we assume that some of that area has returned to

cultivation with the departure of the Soviets, then the "other area reduction" coefficient can be assigned a value of 0.5 (i.e., approximately the minimum amount of reduction below the level of 0.67 (1/3 fallow) as stated by the Swedish Committee).

$C_R$ = 0.50

d. Other Competing Crops: as stated previously, Herat is not reported as an area with significant competing poppy.

$C_C$ = 1.00

3. Province Summary--Herat

$TA_A$ = 476,170 ha

| Irrigated wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.85 | $C_{RW}$ | = | 0.05 |
| $C_D$ | = | 0.60 | $C_R$ | = | 0.50 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| | | | | | |
| $A_{IW}$ | = | 242,850 ha | $A_{RW}$ | = | 11,900 ha |

## II. NORTHWEST REGION

### A. Badghis Province

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 146,290 ha

b. Irrigated Wheat Dominance: Badghis is 100 percent within the boundary of the rainfed wheat-dominated area. Since 85% of the area will be rainfed here, then the coefficient for irrigated wheat will be 0.05 (5% of total crop area).

$C_W$ = 0.05

c. Irrigation Damage/Abandonment: Badghis is rated by Dr. Wakil as None/Slight. This coefficient will therefore be valued at 0.90

$C_D$ = 0.90

d. Competing Crops: Again, this area has not been identified as having large concentrations of poppy or other crops in place of wheat. Coefficient of competing crops will therefore be 1.00.

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 146,290 ha

b. Dominance of Rainfed Wheat: according to Dr. Wakil, rainfed wheat accounts for upwards of 85% of all crop area in Badghis province. Coefficient of rainfed wheat dominance is 0.85.

$C_{RW}$ = 0.85

c. Other reported area reduction: we have not detected any reports of heavy cropland damage in Badghis province. Since rainfed agriculture generally does not utilize fertilizer, natural fertility is low. Traditionally, up to 1/3 of available annual crop land is left fallow each year. We feel that this would still apply to large rainfed wheat tracts as are found in Badghis. The only other limitations would be (1) seed availability (not thought to be affected, since rainfed wheat is mainly domestic seed supply), (2) labor shortage in planting and harvest (DAI estimates 20-35% of population in refugee status), and (3) farmer expectations for the weather. The latter factor is unmeasureable; the previous year supposedly had less than average rainfall. If this were a "normal" year, we would expect to see around 67% of the rainfed land in wheat. Given the population reduction, the coefficient of area reduction will be set at 50%.

$C_R$ = 0.50

d. Competing Crops: Again, this area has not been identified as having large concentrations of poppy or other crops in place of wheat. Coefficient of competing crops will therefore be 1.00.

$C_C$ = 1.00

3. Province Summary--Badghis

$TA_A$ = 146,290 ha

| Irrigated wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.05 | $C_{RW}$ | = | 0.85 |
| $C_D$ | = | 0.90 | $C_R$ | = | 0.50 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 6,580 ha | $A_{RW}$ | = | 62,170 ha |

B. **Farayab Province**

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 301,950 ha

b. Irrigated Wheat Dominance: Farayab is completely contained within the area described by Dr. Wakil as dominated by rainfed wheat. Only a small percentage of farmers described in the SCA report grew irrigated wheat. The coefficient of irrigated wheat dominance will therefore be 0.05.

$C_W$ = 0.05

c. Irrigation Damage or Abandonment: Although the SCA reports "widespread distruction of irrigation systems in the early part of the war", no other source describes this. SCA indicates a switch to rainfed crops, as evidenced by a decrease in reported areas in irrigated and a corresponding increase in area in rainfed between 1978 and 1980, followed by a return to "'normal' slow decline for most crops." Dr. Wakil reported this area to have none to slight damage/abandonment. The coefficient of irrigation damage/abandonment will be set at 0.85.

$C_D$ = 0.85

d. Competing Crops: we have no reports of significant poppy cultivation in Farayab. This coefficient will be 1.00.

$C_C$ = 1.00

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 301,950 ha

b. Dominance of Rainfed Wheat: Dr. Wakil includes this province in those areas with in excess of 85% of annual crop area in spring wheat. The SCA report agrees, but says that there is a high percentage of farmers who grow rainfed barley as well. This coefficient will be set at 0.80 to account for competing rainfed crops.

$C_{RW}$ = 0.80

c. Other area reductions: DAI reports that less than 10% of the population of the province registered as refugees. This means that total area committed to rainfed wheat is a function only of (1) normal fallowing practices, and (2) farmer expectations on the

weather. If 1/3 of the area committed to wheat is left fallow, then a coefficient of 0.60 also takes into account the other factors.

$C_R$ = 0.60

d. Competing Crops: we have no reports of significant poppy cultivation in Farayab. This coefficient will be 1.00.

3. Province Summary--Farayab

$TA_A$ = 301,950 ha

| Irrigated wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.05 | $C_{RW}$ | = | 0.80 |
| $C_D$ | = | 0.85 | $C_R$ | = | 0.60 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 12,830 ha | $A_{RW}$ | = | 144,940 ha |

## C. Jowzjan Province

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 271,480 ha

b. Irrigated Wheat Dominance: Like Farayab, rainfed wheat predominates in Jowzjan. However, SCA reports that a larger percentage of farmers grow irrigated wheat than in Farayab. This coefficient will be set at 0.10.

$C_W$ = 0.10

c. Damage or Abandonment of Irrigation: Jowzjan is classified as "none to slight" by Dr. Wakil. No other source mentions it. This coefficient will be set at 0.90.

$C_D$ = 0.95

d. Competing Crops: we have no reports of significant poppy cultivation in Jowzjan. This coefficient will be 1.00.

$C_C$ = 1.00

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 271,480 ha

b. Dominance of Rainfed Wheat: Rainfed wheat predominates in Jowzjan, but as mentioned above, a larger proportion of farmers are reported to grow irrigated wheat as well than in Faryab province. This coefficient will be set at 0.80.

$C_{RW}$ = 0.80

c. Other Reductions: war damage and population decrease are both reported as very slight. The major impact would appear to be infestations (affecting yield, in turn affecting profits, in turn affecting ability to plant the same area each year) and farmer views on weather. Assuming that 1/3 of the land available for irrigated wheat is left fallow, this coefficient will be set at 0.50 to account for this and these other factors.

$C_R$ = 0.50

d. Competing Crops: we have no reports of significant poppy cultivation in Jowzjan. This coefficient will be 1.00.

$C_C$ = 1.00

3. Province Summary--Jowzjan

$TA_A$ = 271,480 ha

| Irrigated wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.10 | $C_{RW}$ | = | 0.80 |
| $C_D$ | = | 0.95 | $C_R$ | = | 0.50 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 25,790 ha | $A_{RW}$ | = | 108,590 ha |

## D. Balkh Province

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 299,410 ha

b. Dominance of Irrigated Wheat: From Dr. Wakil's delineation, about 85% of Balkh falls in the rainfed wheat-dominated area. Dominance of irrigated wheat is therefore 90% of 15% of the total, plus 5% of 85% of the total, or about 18%.

$C_W$ = 0.18

c. Damage or Abandonment of Irrigation: Reported by Dr. Wakil to be none to slight. No other reports of damage in this province.

$C_D$ = 0.95

d. Competing Crops: there is again no reported significant poppy cultivation in Balkh.

$C_C$ = 1.00

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 299,410 ha

b. Dominance of Rainfed Wheat: when added to the coefficient of irrigated wheat, adding to 0.90, this coefficient is set at 0.72

$C_{RW}$ = 0.72

c. Other Reduction Factors: war damage and population reduction are both reported as none to slight. Sunn pest infestation is reported as slight. Assuming that 1/3 of the available rainfed wheat area is left fallow, a factor of 0.60 will be set for Balkh.

$C_R$ = 0.60

d. Competing Crops: again, significant poppy cultivation is not reported in Balkh.

$C_C$ = 1.00

3. Province Summary--Balkh

$TA_A$ = 299,410 ha

| Irrigated wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.18 | $C_{RW}$ | = | 0.72 |
| $C_D$ | = | 0.95 | $C_R$ | = | 0.60 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 51,200 ha | $A_{RW}$ | = | 129,350 ha |

## E. Samangan Province

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 181,250 ha

b. Dominance of Irrigated Wheat: Samangan is about 60% within the irrigated zone. Therefore, 90% of 60%, plus 5% of 40% is the irrigated wheat dominance coefficient, or 0.56.

$C_W$ = 0.56

c. Abandonment or Damage to Irrigation: Dr. Wakil rated this province as none to slight. No other source reports this area as having significant damage to irrigation.

$C_D$ = 0.95

d. Competing Crops: DAI discussions reported some significant concentrations of poppy production in Samangan. The amount is unknown. This coefficient will be set at 0.75.

$C_C$ = 0.75

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 181,250 ha

b. Dominance of Rainfed Wheat: About 85% of 40% of the province is dominated by rainfed wheat, per Dr. Wakil. This coefficient is 0.34.

$C_{RW}$ = 0.34

c. Other Reduction Factors: Population reduction and war damage are reported slight, although the SCA reports a shortage of farm power and labor affecting yield of rainfed wheat. Sunn Pest infestation is reported as slight. Assuming that 1/3 of the rainfed land is normally fallow, this coefficient is set at 0.60.

$C_R$ = 0.60

d: Competing Crops: the reported poppy cultiviation is assumed to compete with irrigated wheat, not rainfed. This coefficient is 1.00.

$C_C$ = 1.00

3. Province Summary--Samangan

$TA_A$ = 181,250 ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.56 | $C_{RW}$ | = | 0.34 |
| $C_D$ | = | 0.95 | $C_R$ | = | 0.60 |
| $C_C$ | = | 0.75 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 72,320 ha | $A_{RW}$ | = | 36,980 ha |

## III. NORTH REGION

### A. Baghlan Province

#### 1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 219,340 ha

b. Dominance of Irrigated Wheat: Irrigated wheat is dominant in Baghlan. SCA reports that 80% of farmers in Baghlan irrigate all their crops. 5% have large, all-rainfed farms. The remainder are mixed. The 90% factor for rainfed dominance seems inappropriate here; the coefficient will be set at 75%

$C_W$ = 0.75

c: Damage or Abandonemt of Irrigation: Dr. Wakil reports moderate damage to irrigation in Baghlan, directly attributable to the war. The SCA also mentions direct war damage to irrigation. This coefficient will be set at 0.50.

$C_D$ = 0.60

d: Competing Crops: DAI discussions reported some significant concentrations of poppy production in Baghlan. The amount is unknown. This coefficient will be set at 0.75.

$C_C$ = 0.75

#### 2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 219,340 ha

b. Dominance of Rainfed Wheat: as stated above, irrigated wheat is dominant, but there are large tracts of rainfed land. This coefficient will be set at 0.15

$C_{RW}$ = 0.15

c. Other Reduction Factors: According to DAI, Baghlan has suffered a 35 to 50% reduction in population. There was also significant war damage here, as the province lies on the road from Kabul to the Soviet Union. Assuming a 1/3 fallow ratio for lands dedicated to rainfed wheat, a coefficient of 0.40 is set to represent these impacts.

$C_{RW}$ = 0.40

# 2.0 ESTIMATION OF AREA DEDICATED TO WHEAT

## 2.1 Methodology

The eventual methodology for calculation of area in wheat will involve direct measurement of agricultural area from satellite imagery, then reducing the total by various coefficients to account for other factors. Finally, a figure will be added to account for areas of the country not covered by the satellite imagery. Unfortunately, the lack of satellite imagery availability at the time of this calculation necessitates an alternate means of calculating the area of total agriculture. We have obtained estimates of annual crop area by province from historical statistical data published by the Afghan government in 1973, covering the year 1971. A review of the reported total national acreage in wheat as reported by USDA shows that the area has been on the average static over the time period 1971 to 1978 (the last "normal" year). The calculation of area of wheat without satellite imagery will utilize the 1971 area data as a base. The area for each province (in Afghan jeribs) will be first converted to hectares. This figure will be known as Total Area of Annual Crop ($TA_A$). This value will be reduced through the use of three coefficients for both the irrigated and rainfed crop in each province. The coefficients are defined below.

### 2.1.1 Coefficient of Wheat Dominance

a. We know that "normally", wheat occupies between 90 and 100 percent of the annual crop land (that not dedicated to horticulture) in Afghanistan. For each province dominated by irrigated farming (as defined by expert opinion), a coefficient of irrigated wheat dominance ($C_W$) will be established. The highest possible value will be 0.90, or 90% of available annual crop land. This figure may be reduced on a province-by-province basis from other corollary data as available. In particular, this coefficient will be greatly reduced in provinces dominated by rainfed wheat (see b. below).

b. For areas dominated by spring (rainfed) wheat, we know that spring wheat accounts for about 85 percent of the total crop area in the areas delineated by Dr. Wakil (see map). For provinces completly within the zone of rainfed dominance, the Coefficient of Rainfed Wheat Dominance ($C_{RW}$) will be at most 0.85, or 85% of available annual crop land. As with irrigated-dominated provinces, these numbers will be modified slightly as corollary information is available. In provinces divided by the line dividing the rainfed and irrigated zones, described by expert opinion, a coefficient representing the expected totals for each kind of wheat will be calculated based upon corollary information.

d. Competing Crops: the reported poppy cultiviation is assumed to compete with irrigated wheat, not rainfed. This coefficient is 1.00.

$C_C$ = 1.00

3. Province Summary--Baghlan

$TA_A$ = 219,340 ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.75 | $C_{RW}$ | = | 0.15 |
| $C_D$ | = | 0.60 | $C_R$ | = | 0.40 |
| $C_C$ | = | 0.75 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 74,030 ha | $A_{RW}$ | = | 13,160 ha |

## B. Kunduz Province

1. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 277,540 ha

b. Dominance of Irrigated Wheat: Kunduz is dominated by irrigated wheat. SCA reports that the average farm is half irrigated, half rainfed. Larger farms are 100% rainfed. There is no quantification of the proportions of large to small farms, although rainfed wheat is listed in the "top four" crops for the province. The coefficient of irrigated wheat dominance will be 0.70.

$C_W$ = 0.70

c. Damage or Abandonment of Irrigation: Dr. Wakil includes Kunduz in the "none/slight" category. SCA identifies lack of irrigation water as the third or fourth leading problem of agriculture in Kunduz. DAI identifies Kunduz as having 20-35% of the population in refugee status. This coefficient will be set at 0.70.

$C_D$ = 0.70

d. Competing Crops: DAI discussions identified some significant concentrations of poppy cultivation in Kunduz. The amount is unknown at this time. This coefficient will be set at 0.75.

$C_C$ = 0.75

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 277,540 ha

b. Dominance of Rainfed Wheat: as mentioned above, SCA reports that the average farmer has a mixed farm, with more rainfed than irrigated land. This is from a sample, however, and may not be representative of the entire farm population of the province.

$C_{RW} = 0.20$

c. Other Reductions: Kunduz is included in the "none to slight" war damage category by Dr. Wakil. The other reported problem (SCA) is farm labor. DAI's evaluation of refugee status concurs. Assuming that 1/3 of the rainfed area is left fallow each year, this coefficient is set at 0.45 to account for farm labor.

$C_R = 0.45$

d: Competing Crops: the poppy cultivation is assumed to compete with irrigated wheat, not rainfed. This coefficient is set at 1.00.

$C_C = 1.00$

3. Province Summary--Kunduz

$TA_A = 277{,}540$ ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.70 | $C_{RW}$ | = | 0.20 |
| $C_D$ | = | 0.70 | $C_R$ | = | 0.45 |
| $C_C$ | = | 0.75 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 102,000 ha | $A_{RW}$ | = | 24,980 ha |

## C. Takhar Province

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A = 345{,}700$ ha

b. Dominance of Irrigated Wheat: In Dr. Wakil's delineation, Takhar is approximately 70% in the irrigated-dominated zone, and 30% in the rainfed-dominated zone. SCA reports a large concentration of very large farms, the majority of which are 99-100% rainfed. They also report that smaller farms were 50-50% split between rainfed and irrigated, down to the smallest farms reported. A larger area of rainfed wheat is reported than irrigated. Dominance of irrigated wheat will be 0.40.

$C_W = 0.40$

c. Damage or Abandonment of Irrigation: Dr. Wakil reports Takhar in the none to slight category. Although SCA discusses the fact that smaller farmers (i.e.,

those with a larger percentage of irrigated farms) tended to leave from Takhar, a reduction in water supply is not mentioned as being among the leading problems. This coefficient will be set at 0.90.

$C_D$ = 0.90

d. Competing Crops: no areas of significant poppy cultivation are reported. This coefficient is set at 1.00.

$C_C$ = 1.00

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 345,700 ha

b. Dominance of Rainfed Wheat: See above discussion of rainfed vs. irrigated wheat. This coefficient is set at 0.50

$C_{RW}$ = 0.50

c. Other Reduction Factors: SCA mentions a reduction in farm labor as the principal farm production problem. DAI lists Takhar with less than 10% refugee status. Assuming that 1/3 of the rainfed land is fallow each year, this coefficient will be set at 0.65.

$C_R$ = 0.65

d. Competing Crops: none reported.

$C_C$ = 1.00

3. Province Summary--Takhar

$TA_A$ = 345,700 ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.40 | $C_{RW}$ | = | 0.50 |
| $C_D$ | = | 0.90 | $C_R$ | = | 0.65 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 124,450 ha | $A_{RW}$ | = | 112,350 ha |

## III. NORTHEAST REGION

### A. Badakhshan Province

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 173,830 ha

b. Dominance of Irrigated Wheat: Dr. Wakil's delineation shows about 45% of Badakhshan being in the irrigated-dominated area. However, a large portion of this area is located in the high peaks of the Hindu Kush and the Wakhan Corridor. SCA says that rainfed farming is predominant. The rainfed:irrigated area ratio shown by SCA is about 2:1. This coefficient is set at 0.30.

$C_W$ = 0.30

c. Damage or Abandonment of Irrigation: This province is described as having essentially no irrigation damage. SCA does not mention water supply as a problem reported in their survey. This coefficient is set at 0.95.

$C_D$ = 0.95

d. Competing Crops: discussions with DAI suggest significant areas of poppy cultivation in Badakhshan. The amount is not known at this time. This coefficient is set at 0.75.

$C_C$ = 0.75

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 173,830 ha

b. Dominance of Rainfed Wheat: see above. Set at 0.60.

$C_{RW}$ = 0.60

c: Other Reductions: War damage and population decrease are shown as slight. If we assume that 1/3 of the rainfed wheat area is left fallow, then this coefficient will be set at 0.65.

$C_R$ = 0.65

d: Competing Crops: SCA mentions a doubling of the cultivation of barley 1978-87. Given this province's border position, animal fodder production increases are likely. This coefficient will be set at 0.80.

$C_C$ = 0.80

3. Province Summary--Badakhshan

$TA_A$ = 173,830 ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.30 | $C_{RW}$ | = | 0.60 |
| $C_D$ | = | 0.95 | $C_R$ | = | 0.65 |
| $C_C$ | = | 0.75 | $C_C$ | = | 0.85 |
| $A_{IW}$ | = | 37,160 ha | $A_{RW}$ | = | 57,620 ha |

## V. CENTRAL REGION

### A. Bamyan Province

1. Irrigated Wheat

   a. Total Annual Crop Area

   $TA_A$ = 28,130 ha

   b. Dominance of Irrigated Wheat: Bamyan Province is shown by Dr. Wakil as roughly 70% within the irrigated-dominated area. SCA reports that all farms are very small (likely in this mountainous area), and that the majority are solely irrigated. This coefficient will be calculated as 90% of 70%, plus 15% of 30%, or about 0.68

   $C_W$ = 0.68

   c. Damage or Abandonment of Irrigation: reported as slight by Dr. Wakil. SCA mentions damage here, but does not quantify it. Coefficient set at 0.90.

   $C_D$ = 0.90

   d. Competing Crops: no significant area concentration of poppy is reported. Coefficient 1.00.

   $C_C$ = 1.00

2. Rainfed Wheat

   a. Total Annual Crop Area

   $TA_A$ = 28,130 ha

   b. Dominance of Rainfed Wheat: see above discussion. Coefficient set at 0.22.

   $C_{RW}$ = 0.22

   c. Other Reduction Factors: Bamyan is apparently very isolated due to the mountainous terrain. Population reduction is reported at less than 10%. Assuming that 1/3 of the rainfed land is allowed to be fallow, this coefficient is set at 0.65.

   $C_R$ = 0.65

   d. Competing Crops: none reported.

   $C_C$ = 1.00

3. Province Summary--Bamyan

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $TA_A$ | = | 28,130 ha | | | |
| $C_W$ | = | 0.68 | $C_{RW}$ | = | 0.22 |
| $C_D$ | = | 0.90 | $C_R$ | = | 0.65 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 17,220 ha | $A_{RW}$ | = | 4,020 ha |

**B. Ghor Province**

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 165,630 ha

b. Dominance of Irrigated Wheat: Dr. Wakil's delineation splits Ghor into about 40% irrigated-dominated and 60% rainfed-dominated. Thus, this coefficient is 90% of 40% plus 15% of 60%, or 0.45.

$C_W$ = 0.45

c. Damage or Abandonment of Irrigation: none to slight. SCA discusses irrigation being in primative stages before the war, and indicating that improvement is a major priority. This coefficient will be set at 0.95.

$C_D$ = 0.95

d. Competing Crops: no significant poppy areas reported.

$C_C$ = 1.00

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 165,630 ha

b. Dominance of Rainfed Wheat: See above discussion. Coefficient set at 0.45.

$C_{RW}$ = 0.45

c. Other Reductions: DAI reports a population decrease of 35-50% in Ghor. Assuming that 1/3 of the rainfed land is fallow, this coefficient will be set at 0.50 to account for population loss.

$C_R$ = 0.50

d. Competing Crops: no significant poppy concentrations reported.

$C_C$ = 1.00

3. Province Summary--Ghor

$TA_A$ = 165,630 ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.45 | $C_{RW}$ | = | 0.45 |
| $C_D$ | = | 0.95 | $C_R$ | = | 0.50 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 70,800 ha | $A_{RW}$ | = | 37,300 ha |

# VI. EAST-CENTRAL REGION

## A. Parwan Province

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 42,380 ha

b. Dominance of Irrigated Wheat: Parwan is fully within the irrigated wheat zone described by Dr. Wakil. This is confirmed by SCA, although they mention rainfed wheat as being grown on larger farms. Coefficient is 0.85.

$C_W$ = 0.85

c. Damage or Abandonment of Irrigation: All sources have rated Parwan as one of the areas severely damaged by war. This coefficient will be 0.30.

$C_D$ = 0.30

d: Competing Crops: there is no report of significant poppy concentrations.

$C_C$ = 1.00

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 42,380 ha

b. Dominance of Rainfed Wheat: see above discussion. Coefficient is 0.05.

$C_{RW}$ = 0.05

c. Other Reductions: Parwan has experienced severe damage, and a 20-35% reduction in population. If we assume that 1/3 of the rainfed land is allowed to lie fallow, then this coefficient will be set at 0.30.

$C_R$ = 0.30

d. Competing Crops: none reported.

$C_C$ = 1.00

3. Province Summary--Parwan

$TA_A$ = 42,380 ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.85 | $C_{RW}$ | = | 0.05 |
| $C_D$ | = | 0.30 | $C_R$ | = | 0.30 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 10,810 ha | $A_{RW}$ | = | 640 ha |

## B. Kapisa Province

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 34,770 ha

b. Dominance of Irrigated Wheat: Kapisa is wholly within the irrigated wheat-dominated area defined by Dr. Wakil. No mention of rainfed wheat is found in SCA. Coefficient is 0.90.

$C_W$ = 0.90

c. Damage or Abandonment of Irrigation: SCA makes no mention of damage. However, Afghanistan: a Country Study reports "carpet" bombing conducted by the Soviets in the Panjsher Valley. This would amount to severe damage. Dr. Wakil reports moderate damage to Kapisa as a whole. Coefficient will be set at 0.50.

d. Competing Crops: we are not aware of reported concentrations of poppy in Kapisa.

$C_C$ = 1.00

2. Rainfed Wheat--Nil

3. Province Summary--Kapisa

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $TA_A$ | = | 34,770 ha | | | |
| $C_W$ | = | 0.90 | $C_{RW}$ | = | 0.00 |
| $C_D$ | = | 0.50 | $C_R$ | = | 0.00 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 15,650 ha | $A_{RW}$ | = | 0 ha |

### C. Laghman Province

1. Irrigated Wheat

a. Total Annual Crop Area:

$TA_A$ = 37,890 ha

b. Dominance of Irrigated Wheat: Laghman falls completely within the irrigated wheat-dominated area defined by Dr. Wakil. SCA says what rainfed farming there is constitutes less than 10% of the larger farms (all farms are relatively small). Coefficient is set at 0.85.

$C_W$ = 0.85

c. Damage or Abandonment of Irrigation: Dr. Wakil rates damage in Laghman as moderate. Coefficient is 0.60.

$C_D$ = 0.60

d. Competing Crops: discussions with DAI indicate there may be areas of significant poppy cultivation. Amount is unknown. This coefficient is set at 0.75.

$C_C$ = 0.75

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 37,890 ha

b. Dominance of Rainfed Wheat: extremely low--0.05.

$C_{RW}$ = 0.05

c. Other reductions: Laghman is reported to have greater than 50% of its population as refugees in Pakistan. This indicates heavy fighting, and probably heavy damage to crop lands. Assuming that 1/3 of the rainfed area would be fallow, this coefficient will be set at 0.30.

$C_R$ = 0.30

3. Province Summary--Laghman

$TA_A$ = 37,890 ha

Irrigated Wheat:

$C_W$ = 0.85
$C_D$ = 0.60
$C_C$ = 0.75

$A_{IW}$ = 14,490 ha

Rainfed Wheat:

$C_{RW}$ = 0.05
$C_R$ = 0.30
$C_C$ = 1.00

$A_{RW}$ = 570 ha

## D. Kabul Province

### 1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 62,700 ha

b. Dominance of Irrigated Wheat: Kabul province lies completely within the zone of irrigated wheat dominance. SCA reports that 90% of farmers grow only irrigated crops.

$C_W$ = 0.85

c. Damage or Abandonment of Irrigation: Dr. Wakil rates damage here as moderate. Coefficient is set at 0.60.

$C_D$ = 0.60

d. Competing Crops: there may be some concentrations of poppy in the southeast part of the province. Amount unknown. This coefficient is set at 0.90.

### 2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 62,700 ha

b. Dominance of Rainfed Wheat: see discussion above. Coefficient is 0.05.

$C_{RW}$ = 0.05

c. Other Reductions: Kabul is reported to have less than 10% population reduction, and moderate war damage. Assuming that 1/3 of the rainfed land is left fallow, this coefficient is set at 0.50.

$C_R$ = 0.50

### 2.1.2 Coefficients of Water Availability and Other Reductions

a. According to expert opinion, "if water is available, there is wheat planted." The second coefficient will therefore be a factor for the availability of water for itrrigation, taking into account the reported condition of irrigation systems. Afghan agriculture experts were questioned about damage or abandonment of irrigation systems on a province-by-province basis, and were asked to rate damage and/or abandonment on a scale of None, Slight, Moderate, or Severe. We know from Dr. Azam Gul that at the height of the war (1982-84) that area in wheat dropped an average of 67 percent, with the larger reductions in rainfed areas skewing the average. We will therefore use a factor of 70 percent (i.e., a coefficient of 0.30) reduction for a report of "Severe" damage to or abandonment of irrigation. A factor of 40 percent (coefficient 0.60) will be used for a "Moderate" rating, and a 10 percent factor (0.90 coefficient) for a "Slight" rating. A "None" rating will result in a zero to ten percent (coefficient 1.00 to 0.90). The Coefficient may be further modified to account for extreme labor shortages, as reflected by expert opinion.

b. For the rainfed crop, the second Coefficient will be known as "the Coefficient of Other Reductions." All consulted sources have indicated that fertilizer is not used on rainfed lands, therefore the older wisdom that up to one-third of available land is left fallow in any given year is still applicable to the rainfed sector. The maximum value for this coefficient in the rainfed portion of any province is therefore 0.67. This number may be further reduced by severe labor loss, as Dr. Azam Gul reports that the number one cause of cultivated area reduction is farm labor reduction.

### 2.1.3 Coefficient of Competing Crops

a. We know that poppy competes for area with irrigated wheat, and that its phenology is similar to winter wheat (planted in the fall, harvested before wheat). Therefore, land dedicated to poppy is not available for wheat. Although poppy is interspersed with wheat throughout the country, we feel that the reduction which occurs in step 1 is sufficient to account for small plots. In certain areas, however, we know that poppy accounts for up to 50 percent of the available area. In these provinces, a calculation will first be conducted to estimate the percentage of the total province affected. for example, we know that in the northern Helmand, poppy occupies up to 50 percent of the land. The northern Helmand represents probably 70 percent of the total

d. Competing Crops: none reported.

$C_C$ = 1.00

3. Province Summary--Kabul

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $TA_A$ | = | 62,700 ha | | | |
| $C_W$ | = | 0.85 | $C_{RW}$ | = | 0.05 |
| $C_D$ | = | 0.60 | $C_R$ | = | 0.50 |
| $C_C$ | = | 0.90 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 28,780 ha | $A_{RW}$ | = | 1,570 ha |

## E. Wardak Province

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 26,950 ha

b. Dominance of Irrigated Wheat: Wardak is totally within the irrigated wheat-dominated zone. SCA does not mention rainfed wheat (only barley). Coefficient is 0.90.

$C_W$ = 0.90

c. Abandonment or Damage to Irrigation: Mentioned by SCA as the principal farm problem. Dr. Wakil refers to it as "Moderate". Coefficient is 0.55.

$C_D$ = 0.55

d. Competing Crops: no reported significant areas of poppy are known. Coefficient 1.00

$C_C$ = 1.00

2. Rainfed Wheat--Nil

3. Province Summary--Wardak

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $TA_A$ | = | 26,950 ha | | | |
| $C_W$ | = | 0.90 | $C_{RW}$ | = | 0.00 |
| $C_D$ | = | 0.55 | $C_R$ | = | 0.00 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 13,340 ha | $A_{RW}$ | = | 0 ha |

## F. Lowgar Province

### 1. Irrigatcd Wheat

a. Total Annual Crop Area

$TA_A$ = 40,820 ha

b. Dominance of Irrigated Wheat: Although the province is within the irrigated wheat-dominated area, Dr. Wakil says taht corn is the principal crop in Lowgar, and that a single crop is grown on separate land. The Third Report does not give any indication of the relative importances of wheat and corn. Clearly, the assumption that wheat accounts for 90% of all annual crop land does not apply here. We will assume that irrigated wheat accounts for 50%, corn for 40%, rainfed wheat for 5%, and others for 5%.

$C_W$ = 0.50

c. Damage or Abandonment of Irrigation: Reported by Dr. Wakil as severe. Other sources agree. This coefficient will be 0.30.

$C_D$ = 0.30

d. Competing Crops: Dr. Wakil reports that in an area comprising about 30% of the province, there is up to 50% poppy cultivation. This represents 50% of 30% of the total crop area. In order to remove this area from the calculation, the province will be divided into two portions, and a total calculated for each. The western portion (70% of the province) has a coefficient of competitive crop of 1.0. The eastern portion (30%) has a competitive crop coefficient of 0.5. The total area in irrigated wheat becomes

$$A_{IW} = [TA_A(0.7) \times C_W \times C_D \times C_{C1}] + [TA_A(0.3) \times C_W \times C_D \times C_{C2}].$$

The coefficient of competing crop will be 0.5 for the eastern 30% of the province ($C_{C2}$), and 1.0 for the western 70% ($C_{C1}$). From this calculation, the blended coefficient is about 0.85.

### 2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 40,820 ha

b. Dominance of Rainfed Wheat: see above discussion. Rainfed represents only about 5% of the total crop area. Coefficient will be 0.05.

$C_{RW}$ = 0.05

c. Other Reduction Factors: As mentioned above, damage and population loss in Lowgar are severe. This coefficient will be set at 0.20.

$C_R$ = 0.20

3. Province Summary--Lowgar

$TA_A$ = 40,820 ha
Irrigated Wheat:
$C_W$ = 0.50
$C_D$ = 0.30
$C_{C1}$ = 1.00
$C_{C2}$ = 0.50

$A_{IW}$ = [0.7(40,820) x 0.5 x 0.3 x 1.0] + [0.3(40,820 x 0.5 x 0.3 x0.5)]
= 5,200 ha (rounded)

Rainfed Wheat:
$C_{RW}$ = 0.05
$C_R$ = 0.20
$C_C$ = 1.00
$A_{RW}$ = 410 ha

# VII. SOUTH-CENTRAL REGION

## A. Uruzghan Province

### 1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 125,000 ha

b. Dominance of Irrigated Wheat: only a small band of norther Uruzghan (about 10%) is located in the rainfed-dominated area. The remainder is in the irrigated-dominated area. Thus, the coefficient of irrigated dominance is about 5% of 10% of the area, plus about 80% of the remaining 90% (based on SCA assessment of rainfed wheat in the entire province), or about 0.73 total.

$C_W$ = 0.73

c. Damage or Abandonment of Irrigation: reported slight by Dr. Wakil; not mentioned by other sources. However, a reported 35-50% drop in population is reported by DAI, decreasing the available work force to maintain irrigation. Coefficient will be therefore set at 0.70

$C_D$ = 0.70

d. Competing Crop: Dr. Wakil's delineation of significant poppy cultiviation includes about 15% of southern Uruzghan. In this area, we can expect poppy to occupy 50% of the available irrigated wheat land. Coefficient is calculated as 100% minus 50% of 15% (about 8%), or 0.92.

$C_C$ = 0.92

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 125,000 ha

b. Dominance of Rainfed Wheat: 85% on 10% of the land, plus 10% on 90% of the land, or about 0.18.

$C_{RW}$ = 0.18

c. Other Reduction Factors: According to DAI, there has been a 35 to 50% reduction in population in Uruzghan. Assuming that 1/3 of rainfed area would normally be fallow, this coefficient is set at 0.40 to account for population decrease.

$C_R$ = 0.40

d. Competing Crops: the poppy crop is assumed to compete with irrigated wheat. No other unaccounted competition is reported.

$C_C$ = 1.00

3. Province Summary

$TA_A$ = 125,000 ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.73 | $C_{RW}$ | = | 0.18 |
| $C_D$ | = | 0.70 | $C_R$ | = | 0.40 |
| $C_C$ | = | 0.92 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 58,770 ha | $A_{RW}$ | = | 9,000 ha |

## B. Ghazni Province

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 159,180 ha

b. Dominance of Irrigated Wheat: Ghazni falls completely within the irrigated-dominated area delineated by Dr. Wakil. The SCA reports small amounts of rainfed wheat, mainly among those in the survey who left the country. The coefficient will be set at 85% to account for the rainfed area.

$C_W$ = 0.80

c. Damage or Abandonment of Irrigation: Dr. Wakil describes it as moderate. The SCA report says Ghazni suffered some of the worst damage of the war. There is confirmation from Dr. Shroder and Mr. Bashir (Shroder reports that

the flood gates on the major irrigating reservoir in the province have been open for several years, and abandonment of karez irrigation is evident from satellite imagery). However, in discussions with USAID and other officials, Ghazni is a province which has been targeted for large amounts of assistance, given its proximity to Pakistan and the previously existing irrigated development. At the current time, we do not have a good feeling for the amount of success of the assistance programs. This coefficient will be estimated between the slight and moderate levels at 0.75.

$C_D$ = 0.75

d: Competing Crop: we are not aware of significant concentrations of poppy in Ghazni.

$C_C$ = 1.00

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 159,180 ha

b. Dominance of Rainfed Wheat: see above. Coefficient is set at 0.05.
$C_{RW}$ = 0.05

c. Other Reduction Factors: Ghazni has experienced a reported population decline greater than 50% (DAI). SCA reports a hevy toll of oxen casualties in the war. Assuming that 1/3 of the rainfed area is left fallow in a normal year, this coefficient is set at 0.35 to account for these factors.

$C_R$ = 0.35

d. Competing Crop: none reported that is not already accounted for.

$C_C$ = 1.00

3. Province Summary

$TA_A$ = 159,180 ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.80 | $C_{RW}$ | = | 0.10 |
| $C_D$ | = | 0.75 | $C_R$ | = | 0.35 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 95,510 ha | $A_{RW}$ | = | 5,570 ha |

## C. Zabul Province

### 1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 76,370 ha

b. Dominance of Irrigated Wheat: Zabul is completely within the irrigated wheat-dominated zone described by Dr. Wakil. SCA says that over 90% of all farms are all irrigated. Since the rainfed portions are larger than irrigated, the coefficient will be reduced slightly from 90% of 90%.

$C_W$ = 0.79

c. Damage or Abandonment of Irrigation: reported slight by Dr. Wakil; no mention by SCA. However, Zabul had a 35-50% population reduction reported by DAI. Coefficient will be set at 0.70 to account for a reduction of maintenence of irrigation.

$C_D$ = 0.70

d. Competing Crop: we are unaware of significant poppy cultivation.

$C_C$ = 1.00

### 2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 76,370 ha

b. Dominance of Rainfed Wheat: see above. Coefficient will be 0.11

$C_{RW}$ = 0.11

c. Other Reduction Factors: war damage is reported by Dr. Wakil as slight, but a population reduction of 35-50% has been reported. Assuming 1/3 of rainfed land is left fallow, the coefficient will be set at 0.50 to account for population loss.

$C_R$ = 0.50

d. Competing Crop: none reported that has not already been accounted for.

$C_C$ = 1.00

3. Province Summary--Zabul

| | | | | | |
|---|---|---|---|---|---|
| $TA_A$ | = | 76,370 ha | | | |
| Irrigated Wheat: | | | Rainfed Wheat: | | |
| $C_W$ | = | 0.79 | $C_{RW}$ | = | 0.11 |
| $C_D$ | = | 0.70 | $C_R$ | = | 0.50 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 42,230 ha | $A_{RW}$ | = | 4,200 ha |

# VIII. EAST REGION

## A. Ningrehar Province

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 82,420 ha

b. Dominance of Irrigated Wheat: Ningrehar lies completely within the irrigated wheat-dominated region of the country. SCA reports an almost clean split between all-irrigated and all-rainfed farms, with "over three-quarters" of those still in Afghanistan having all irrigated (assumed to be around 76%), and about 19% having all rainfed. If we assume that the other 5% have an even mix of both types, the coefficient of dominance is about 79%.

$C_W$ = 0.79

c. Damage or Abandonment of Irrigation: war damage in Ningrehar is reported as moderate by Dr. Wakil, and severe by other sources (this is logical because of Ningrehar's strategic location on the road to Khyber Pass). Additionally, a 35-50% population reduction is reported. This coefficient will be set at 0.45.

$C_D$ = 0.45

d. Competing Crop: Dr. wakil's delineation of significant poppy cultivation areas included about 20% of Ningrehar province. Since irrigated crops represent about 95% of the arable land, and because of Dr. Wakil's statement of 50% poppy cultivation in these areas, this represents about 50% of 95% of 20% of the Province, or about 10% of the total area. Coefficient is 0.90.

$C_C$ = 0.90

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 82,420 ha

b. Dominance of Rainfed Wheat: from above discussion, about 11%.

$C_{RW}$ = 0.11

c. Other Reduction Factors: Reported moderate to severe war damage; 35 to 50% reduction in population. Assuming that 1/3 of rainfed land is left fallow, this coefficient will be set at 0.50 to account for population loss.

$C_R$ = 0.50

d. Competing Crop: SCA reports a large increase in barley as horse fodder. This is logical given Ningrehar's location on the border. This coefficient will be set at 0.90

$C_C$ = 0.90

3. Province Summary--Ningrehar

$TA_A$ = 82,420 ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.79 | $C_{RW}$ | = | 0.11 |
| $C_D$ | = | 0.70 | $C_R$ | = | 0.50 |
| $C_C$ | = | 1.00 | $C_C$ | = | 0.90 |
| $A_{IW}$ | = | 45,580 ha | $A_{RW}$ | = | 4,080 ha |

## B. Kunar Province

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 29,100 ha

b. Dominance of Irrigated Wheat: Kunar lies within the irrigated-dominated region of Afghanistan. SCA reports a higher proportion of rainfed land than in other provinces in this area. Coefficient will be set at 0.75

$C_W$ = 0.75

c. Damage or Abandonment of Irrigation: reported as moderate by Dr. Wakil. Other sources say severe. Population loss in excess of 50% seems to confirm the "severe". Coefficient will be set at 0.40.

$C_D$ = 0.40

d. Competing Crop: DAI reported some potential significant areas of poppy cultivation in Kunar. Amount unknown. This coefficient will be set at 0.75.

$C_C$ = 0.75

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 29,100 ha

b. Dominance of Rainfed Wheat: see above discussion. Coefficient is set at 0.15.

$C_{RW}$ = 0.15

c. Other Reduction Factors: population loss of >50%; moderate to severe war damage. Assuming 1/3 of rainfed land would be fallow, coefficient is set at 0.30

$C_R$ = 0.30

d. Competing Crop: none reported not already accounted for.

$C_C$ = 1.00

3. Province Summary--Kunar

$TA_A$ = 29,100 ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.75 | $C_{RW}$ | = | 0.15 |
| $C_D$ | = | 0.40 | $C_R$ | = | 0.30 |
| $C_C$ | = | 0.75 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 6,550 ha | $A_{RW}$ | = | 1,310 ha |

## C. Paktia/Paktika Provinces

NOTE: in the 1973 Afghan data, only Paktia was listed. Reference to maps of the period show a single province in place of the two listed here. for the purpose of this calculation, the two provinces will be considered together.

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 82,230 ha

b. Dominance of Irrigated Wheat: The provinces are within the irrigated wheat-dominated zone. SCA reports that almost all farmers in Paktika irrigate all their land, and the same for Paktia. Coefficient will be set at 0.80.

$C_W$ = 0.80

c. Damage or Abandonment of Irrigation: Afghanistan: A Country Study reports heavy war damage to Paktia and Paktika. Dr. Wakil rates both provinces as slight for irrigation damage. SCA does not mention irrigation reduction, but

does mention a reduction in irrigated crops in the period 1978-1987. This factor will be set between slight and moderate, at 0.75.

$C_D$ = 0:75

d. Competing Crop: Dr. Wakil's delineation of heavy poppy cultivation includes about 5% of the total area of both provinces (located at the northern end of Paktia at the border with Lowgar). Reduction would be 50% of 5% or 2.5% (rounded to 3%). Coefficient will be 0.97.

$C_C$ = 0.97

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 82,230 ha

b. Dominance of Rainfed Wheat: see above. Coefficient is 0.10

$C_{RW}$ = 0.10

c. Other Reduction Factors: although one source reports heavy damage in both provinces, no other source confirms. Assuming 1/3 of rainfed land is left fallow, this coefficient will be set at 0.55.

$C_R$ = 0.55

d. Competing Crop: none reported not already accounted for.

$C_C$ = 1.00

3. Province Summary--Paktia/Paktika

$TA_A$ = 82,230 ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.80 | $C_{RW}$ | = | 0.10 |
| $C_D$ | = | 0.75 | $C_R$ | = | 0.55 |
| $C_C$ | = | 0.97 | $C_C$ | = | 1.00 |
| | | | | | |
| $A_{IW}$ | = | 47,860 ha | $A_{RW}$ | = | 4,520 ha |

crop area of the province, so poppy occupies 50 percent of 70 percent of the total, or 35 percent of the total available area. The number arrived at in step 2 will be therefore multiplied by 0.65 to account for poppy cultivation in Helmand.

Provinces affected by reported competing irrigated crops include Helmand, Kandahar, Uruzghan, Farah, Ningrehar, Paktia, Kunar, and Badakhshan (Poppy), and Lowgar (according to Dr. Wakil, a single crop of corn is the dominant crop here). In the rainfed sector, the coefficient of competing crop will be 1.00 in all provinces except those in which there are reports of increased growth of rainfed fodder crops.

Note: a high Coefficient indicates little competition from other crop. A low Coefficient indicates significant competition.

The procedure for calculation of irrigated wheat is as follows:

$$A_{IW} = TA_A * C_W * C_D * C_C$$

Where:
$A_{IW}$ = Total Irrigated Wheat Area
$TA_A$ = Total Annual Crop Area (from Afghan Govt)
$C_W$ = Coefficient of Irrigated Wheat Dominance
$C_D$ = Coefficient of Water Availability
$C_C$ = Coefficient of Competing Crops

The procedure for calculation of rainfed wheat area is as follows:

$$A_{RW} = TA_A * C_{RW} * C_R * C_C$$

Where:
$A_{RW}$ = Area of Rainfed Wheat
$TA_A$ = Total Annual Crop Area (from Afghan Govt)
$C_{RW}$ = Coefficient of Rainfed Wheat Dominance
$C_R$ = Coefficient of Area Reduction (from other sources)
$C_C$ = Coefficient of Competing Crops

Total wheat area will be the sum of $A_{IW}$ and $A_{RW}$ for each province. The total areas will be rounded to the nearest 10 hectares, since the calculation which enabled us to arrive at hectarages from the 1971 data included a rounding.

## IX. SOUTHWEST REGION

### A. Kandahar Province

#### 1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 139,650 ha

b. Dominance of Irrigated Wheat: Kandahar falls completely in the irrigated wheat-dominant zone. According to SCA, less than 5% of farmers have rainfed land. Coefficient will be set at 0.85.

$C_W$ = 0.85

c. Damage or Abandonment of Irrigation: heavy damage and population loss are reported by all sources. Kandahar's agriculture is relatively high-tech; in addition to actual irrigation damage, the reduction in population severely limits the ability to irrigate land. Coefficient is severe; 0.30.

$C_D$ = 0.30

d. Competing Crop: Dr. Wakil and DAI both identify northern Kandahar has having significant poppy cultivation. Dr. Wakil's delineation includes about 20% of the province, but this area probably represents 30-40% of the principal agricultural area. Coefficient is therefore set at 50% of 35%, or about 18% reduction. Coefficient is 0.82.

$C_C$ = 0.82

#### 2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 139,650 ha

b. Dominance of Rainfed Wheat: as mentioned above, very limited. Coefficient is 0.05.

$C_{RW}$ = 0.05

c. Other Reduction Factors: Large population loss (>50%) and severe war damage. Assuming 1/3 of rainfed land is fallow, coefficient is set at 0.10.

$C_R$ = 0.10

d. Competing Crop: none reported not already accounted for.

$C_C$ = 1.00

3. Province Summary--Kandahar

$TA_A$ = 139,650 ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.85 | $C_{RW}$ | = | 0.05 |
| $C_D$ | = | 0.30 | $C_R$ | = | 0.10 |
| $C_C$ | = | 0.82 | $C_C$ | = | 1.00 |

$A_{IW}$ = 29,200 ha $A_{RW}$ = 700 ha

B. Helmand Province

1. Irrigated wheat

a. Total Annual Crop Area

$TA_A$ = 154,100 ha

b. Dominance of Irrigated Wheat: Helmand lies completely within the irrigated wheat-dominated area as defined by Dr. Wakil. SCA reports that of those farmer surveyed who stayed, about 80% have only irrigated land, and the rest have mixed farms. The coefficient will be set at 0.80.

$C_W$ = 0.80

c. Damage or Abandonment of Irrigation: Reported as severe by Dr. Wakil; confirmed by other sources, primarily due to the nature of "this high cost farming system" (SCA). Population has dropped by 35 to 50%. Coefficient will be 0.30.

$C_D$ = 0.30

d: Competing Crop: Dr. Wakil and DAI both report significant poppy cultivation in northern Helmand. The northern Helmand represents probably 70 percent of the total crop area of the province, so poppy occupies 50 percent of 70 percent of the total, or 35 percent of the total available area. Coefficient will be 0.65.

$C_C$ = 0.65

2. Rainfed Wheat

a. Total Annual Crop Area

$TA_A$ = 154,100 ha

b. Dominance of Rainfed Wheat: see above discussion. Coefficient will be 0.10.

$C_{RW}$ = 0.10

c. Other Reduction Factors: Severe war damage and moderate population loss. Assuming that 1/3 of rainfed lands are fallow, the coefficient will be set at 0.30 to reflect damage and population reduction.

$C_R$ = 0.30

3. Province Summary--Helmand

$TA_A$ = 154,100 ha

| Irrigated Wheat: | | | Rainfed Wheat: | | |
|---|---|---|---|---|---|
| $C_W$ | = | 0.80 | $C_{RW}$ | = | 0.10 |
| $C_D$ | = | 0.30 | $C_R$ | = | 0.30 |
| $C_C$ | = | 0.65 | $C_C$ | = | 1.00 |

$A_{IW}$ = 24,040 ha $\quad$ $A_{RW}$ = 4,620 ha

## C. Farah Province

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 142,970 ha

b. Dominance of Irrigated Wheat: Farah lies completely within the irrigated wheat dominated zone defined by Dr. Wakil. SCA reports that in their survey, almost all farmers reported being totally reliant on irrigation. Coefficient is set at 0.90.

$C_W$ = 0.90

c. Damage or Abandonment of Irrigation: Dr. wakil defines as moderate due to abandonment of well system. SCA mentions "war damage" as leading farm problem. Coefficient will be 0.60.

$C_D$ = 0.60

d. Competing Crop: Dr. Wakil delineated an area of eastern Farah as being up to 50% in poppy. This area constitutes about 15% of the province. This coefficient will be 50% of 15%, or about an 8% area reduction. Coefficient = 0.92.

2. Rainfed Wheat--Nil

3. Province Summary--Farah

| | | | | | |
|---|---|---|---|---|---|
| $TA_A$ | = | 142,970 ha | | | |
| Irrigated Wheat: | | | Rainfed Wheat: | | |
| $C_W$ | = | 0.90 | $C_{RW}$ | = | 0.00 |
| $C_D$ | = | 0.60 | $C_R$ | = | 0.00 |
| $C_C$ | = | 0.92 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 71,030 ha | $A_{RW}$ | = | 0 ha |

**D. Nimruz Province**

1. Irrigated Wheat

a. Total Annual Crop Area

$TA_A$ = 182,810 ha

b. Dominance of Irrigated Wheat: Nimruz lies completely in the irrigated wheat-dominated zone defined by Dr. Wakil. SCA reports that all farmers surveyed had 100% irrigated land. Coefficient is 0.90.

$C_W$ = 0.90

c. Damage or Abandonment of Irrigation: described as slight by Dr. Wakil. A greater than 50% loss of population is reported by DAI; SCA says 3/4 of family labor has left. Factor will be set at 0.75 to account for labor loss.

d. Competing Crop: we are not aware of significant poppy areas in Nimruz.

$C_C$ = 1.00

2. Rainfed Wheat--Nil

3. Province Summary--Nimruz

| | | | | | |
|---|---|---|---|---|---|
| $TA_A$ | = | 182,810 ha | | | |
| Irrigated Wheat: | | | Rainfed Wheat: | | |
| $C_W$ | = | 0.90 | $C_{RW}$ | = | 0.00 |
| $C_D$ | = | 0.75 | $C_R$ | = | 0.00 |
| $C_C$ | = | 1.00 | $C_C$ | = | 1.00 |
| $A_{IW}$ | = | 123,400 ha | $A_{RW}$ | = | 0 ha |

## 2.2 Trends Observed in Analysis of Coefficients

### 2.2.1 Coefficients of Wheat Dominance

The provinces of Badghis, Farayab,and Jowzjan are located completely within an area delineated by an Afghan expert as being dominated by rainfed wheat. Therefore, in these provinces, the Coefficient of Rainfed Wheat ($C_{RW}$) is relatively high and the Coefficient of Irrigated Wheat ($C_W$) is relatively low. The provinces of Samangan, Balkh, Takhar, Badakhshan, Ghor, and Bamyan are split by the line of demarcation between rainfed and irrigated wheat dominance. Thus, in these provinces, the two dominance coefficients are more evenly split. In the remainder of the provinces, irrigated wheat predominates, so the Coefficient of Irrigated Wheat is relatively high and the Coefficient of Rainfed Wheat is relatively low.

### 2.2.2 Coefficient of Water Availability

This coefficient, which applies only to irrigated area calculations, is most affected by reports of war damage or abandonment from expert and literature sources. Additionally, a report of high population loss also has a reducing effect, since labor is needed to maintain irrigation. Generally, the northwest, north, northeast, and central provinces had relatively high Coefficients of Water Availability ($C_D$). The east central, east, and southwest provinces had relatively low to moderate coefficients owing to the severity of war damage and population loss. Provinces in the west and south central regions had moderate coefficient reductions.

### 2.2.3 Coefficient of Other Reductions

This coefficient only applies to rainfed wheat area calculations. Based on the knowledge that fertilizer is not used on the rainfed crop, we believe that the accepted truism that about one-third of the available rainfed land is left fallow in any given year. Thus, the highest possible Coefficient of Other Reductions ($C_R$) is 0.67; this represents a "relatively high" coefficient. "Other reductions" include war damage, reductions in the labor force, and the psychological impact of pestilence and lack of rainfall in previous years. The northwest and north provinces had moderate coefficients, based upon the impact of sunn pests and locusts. The northeast and central provinces had relatively high coefficients, owing primarily to their isolation. The east central, east, and south central provinces had low to moderate coefficients based upon impact of war damage and population loss. Finally, the southwest

CROPCAST

JULY 31, 1990

1990 IRRIGATED (WINTER) WHEAT AREA ESTIMATION

| PROVINCE | (Hectares) ANNUAL CROP AREA | Coeff. of Irrigated Wheat | Coeff. of Water Availability | Coeff. of Competing Crop | (Hectares) AREA OF IRRIGATED WHEAT | AREA ROUNDED TO NEAREST 10 HA | REGIONAL TOTAL |
|---|---|---|---|---|---|---|---|
| WEST REGION | | | | | | | |
| Herat | 476,170 | 0.85 | 0.60 | 1.00 | 242,847 | 242,850 | 242,850 |
| NORTHWEST REGION | | | | | | | |
| Badghis | 146,290 | 0.05 | 0.90 | 1.00 | 6,583 | 6,580 | |
| Farayab | 301,950 | 0.05 | 0.85 | 1.00 | 12,833 | 12,830 | |
| Jowzjan | 271,480 | 0.10 | 0.95 | 1.00 | 25,791 | 25,790 | |
| Balkh | 299,410 | 0.18 | 0.95 | 1.00 | 51,199 | 51,200 | |
| Samangan | 181,250 | 0.56 | 0.95 | 0.75 | 72,319 | 72,320 | 168,720 |
| NORTH REGION | | | | | | | |
| Baghlan | 219,340 | 0.75 | 0.60 | 0.75 | 74,027 | 74,030 | |
| Kunduz | 277,540 | 0.70 | 0.70 | 0.75 | 101,996 | 102,000 | |
| Takhar | 345,700 | 0.40 | 0.90 | 1.00 | 124,452 | 124,450 | 300,480 |
| NORTHEAST | | | | | | | |
| Badakhshan | 173,830 | 0.30 | 0.95 | 0.75 | 37,156 | 37,160 | 37,160 |
| CENTRAL | | | | | | | |
| Bamyan | 28,130 | 0.68 | 0.90 | 1.00 | 17,216 | 17,220 | |
| Ghor | 165,630 | 0.45 | 0.95 | 1.00 | 70,807 | 70,810 | 88,030 |
| EAST CENTRAL | | | | | | | |
| Parwan | 42,380 | 0.85 | 0.30 | 1.00 | 10,807 | 10,810 | |
| Kapisa | 34,770 | 0.90 | 0.50 | 1.00 | 15,647 | 15,650 | |
| Laghman | 37,890 | 0.85 | 0.60 | 0.75 | 14,493 | 14,490 | |
| Kabul | 62,700 | 0.85 | 0.60 | 0.90 | 28,779 | 28,780 | |
| Wardak | 26,950 | 0.90 | 0.55 | 1.00 | 13,340 | 13,340 | |
| Lowgar | 40,820 | 0.50 | 0.30 | 0.85 | 5,205 | 5,210 | 88,280 |
| SOUTH CENTRAL | | | | | | | |
| Uruzghan | 125,000 | 0.73 | 0.70 | 0.92 | 58,765 | 58,770 | |
| Ghazni | 159,180 | 0.80 | 0.75 | 1.00 | 95,508 | 95,510 | |
| Zabul | 76,370 | 0.79 | 0.70 | 1.00 | 42,233 | 42,230 | 196,510 |
| EAST | | | | | | | |
| Ninghrehar | 82,420 | 0.79 | 0.45 | 0.90 | 26,370 | 26,370 | |
| Kunar | 29,100 | 0.75 | 0.40 | 0.75 | 6,548 | 6,550 | |
| Paktia/Paktika | 82,230 | 0.80 | 0.75 | 0.97 | 47,858 | 47,860 | 80,780 |
| SOUTHWEST | | | | | | | |
| Kandahar | 139,650 | 0.85 | 0.30 | 0.82 | 29,201 | 29,200 | |
| Helmand | 154,100 | 0.80 | 0.30 | 0.65 | 24,040 | 24,040 | |
| Farah | 142,970 | 0.90 | 0.60 | 0.92 | 71,027 | 71,030 | |
| Nimruz | 182,810 | 0.90 | 0.75 | 1.00 | 123,397 | 123,400 | 247,670 |
| TOTAL | 4,306,060 | | | | 1,450,441 | 1,450,480 | 1,450,480 |

CROPCAST
JULY 31, 1990
1990 RAINFED (SPRING) WHEAT AREA ESTIMATION (Hectares)

| PROVINCE | (Hectares) ANNUAL CROP AREA | Coeff. of Rainfed Wheat | Coeff. of Other Reduction | Coeff. of Competing Crop | AREA OF RAINFED WHEAT | AREA ROUNDED TO NEAREST 10 HA | REGIONAL TOTAL |
|---|---|---|---|---|---|---|---|
| WEST REGION | | | | | | | |
| Herat | 476,170 | 0.05 | 0.50 | 1.00 | 11,904 | 11,900 | 11,900 |
| NORTHWEST REGION | | | | | | | |
| Badghis | 146,290 | 0.85 | 0.50 | 1.00 | 62,173 | 62,170 | |
| Farayab | 301,950 | 0.80 | 0.60 | 1.00 | 144,936 | 144,940 | |
| Jowzjan | 271,480 | 0.80 | 0.50 | 1.00 | 108,592 | 108,590 | |
| Balkh | 299,410 | 0.72 | 0.60 | 1.00 | 129,345 | 129,350 | |
| Samangan | 181,250 | 0.34 | 0.60 | 1.00 | 36,975 | 36,980 | 482,030 |
| NORTH REGION | | | | | | | |
| Baghlan | 219,340 | 0.15 | 0.40 | 1.00 | 13,160 | 13,160 | |
| Kunduz | 277,540 | 0.20 | 0.45 | 1.00 | 24,979 | 24,980 | |
| Takhar | 345,700 | 0.50 | 0.65 | 1.00 | 112,353 | 112,350 | 150,490 |
| NORTHEAST | | | | | | | |
| Badakhshan | 173,830 | 0.60 | 0.65 | 0.80 | 54,235 | 54,240 | 54,240 |
| CENTRAL | | | | | | | |
| Bamyan | 28,130 | 0.22 | 0.65 | 1.00 | 4,023 | 4,020 | |
| Ghor | 165,630 | 0.45 | 0.50 | 1.00 | 37,267 | 37,270 | 41,290 |
| EAST CENTRAL | | | | | | | |
| Parwan | 42,380 | 0.05 | 0.30 | 1.00 | 636 | 640 | |
| Kapisa | 34,770 | 0.00 | 0.00 | 1.00 | 0 | 0 | |
| Laghman | 37,890 | 0.05 | 0.30 | 1.00 | 568 | 570 | |
| Kabul | 62,700 | 0.05 | 0.50 | 1.00 | 1,568 | 1,570 | |
| Wardak | 26,950 | 0.00 | 0.00 | 1.00 | 0 | 0 | |
| Lowgar | 40,820 | 0.05 | 0.20 | 1.00 | 408 | 410 | 3,190 |
| SOUTH CENTRAL | | | | | | | |
| Uruzghan | 125,000 | 0.18 | 0.40 | 1.00 | 9,000 | 9,000 | |
| Ghazni | 159,180 | 0.10 | 0.35 | 1.00 | 5,571 | 5,570 | |
| Zabul | 76,370 | 0.11 | 0.50 | 1.00 | 4,200 | 4,200 | 18,770 |
| EAST | | | | | | | |
| Ninghrehar | 82,420 | 0.11 | 0.50 | 0.90 | 4,080 | 4,080 | |
| Kunar | 29,100 | 0.15 | 0.30 | 1.00 | 1,310 | 1,310 | |
| Paktia/Paktika | 82,230 | 0.10 | 0.55 | 1.00 | 4,523 | 4,520 | 9,910 |
| SOUTHWEST | | | | | | | |
| Kandahar | 139,650 | 0.05 | 0.10 | 1.00 | 698 | 700 | |
| Helmand | 154,100 | 0.10 | 0.30 | 1.00 | 4,623 | 4,620 | |
| Farah | 142,970 | 0.00 | 0.00 | 1.00 | 0 | 0 | |
| Nimruz | 182,810 | 0.00 | 0.00 | 1.00 | 0 | 0 | 5,320 |
| TOTAL | 4,306,060 | | | | 777,126 | 777,140 | 777,140 |

-400

**CROPCAST™ AFGHANISTAN WHEAT FORECAST**

**DOCUMENTATION OF PROCEDURES**
**FOR INITIAL YIELD AND AREA ESTIMATES**

**Prepared for:**

**USAIDREP/P**
**Peshawar, Pakistan**

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